

**Efficient Use of Energy in California  
Power Electronics Conference  
Long Beach, CA  
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**<http://www.energy.ca.gov/commission/commissioners/rosenfeld.html>**

**or just Google “Art Rosenfeld”**

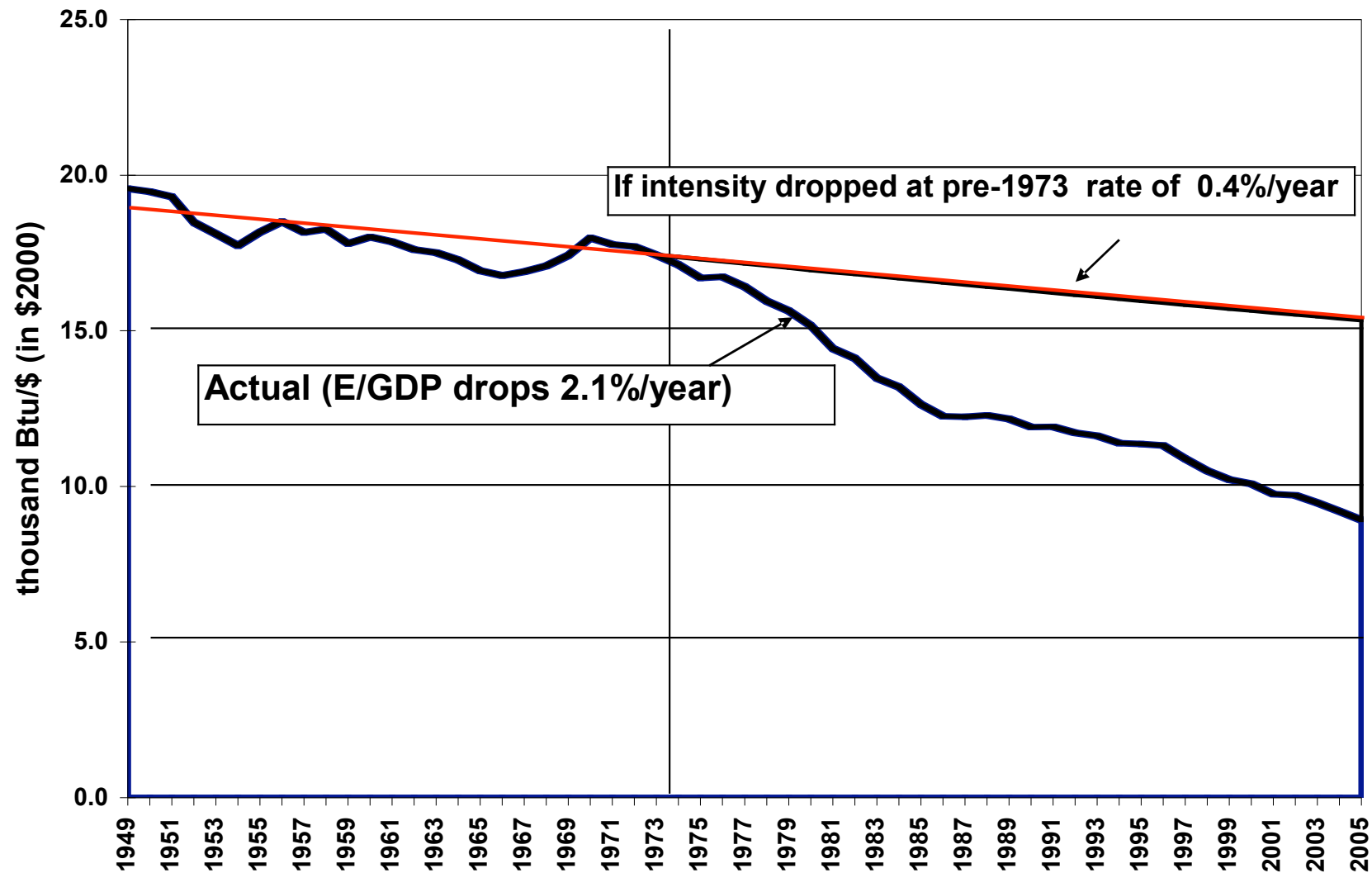
1949

Rosenfeld

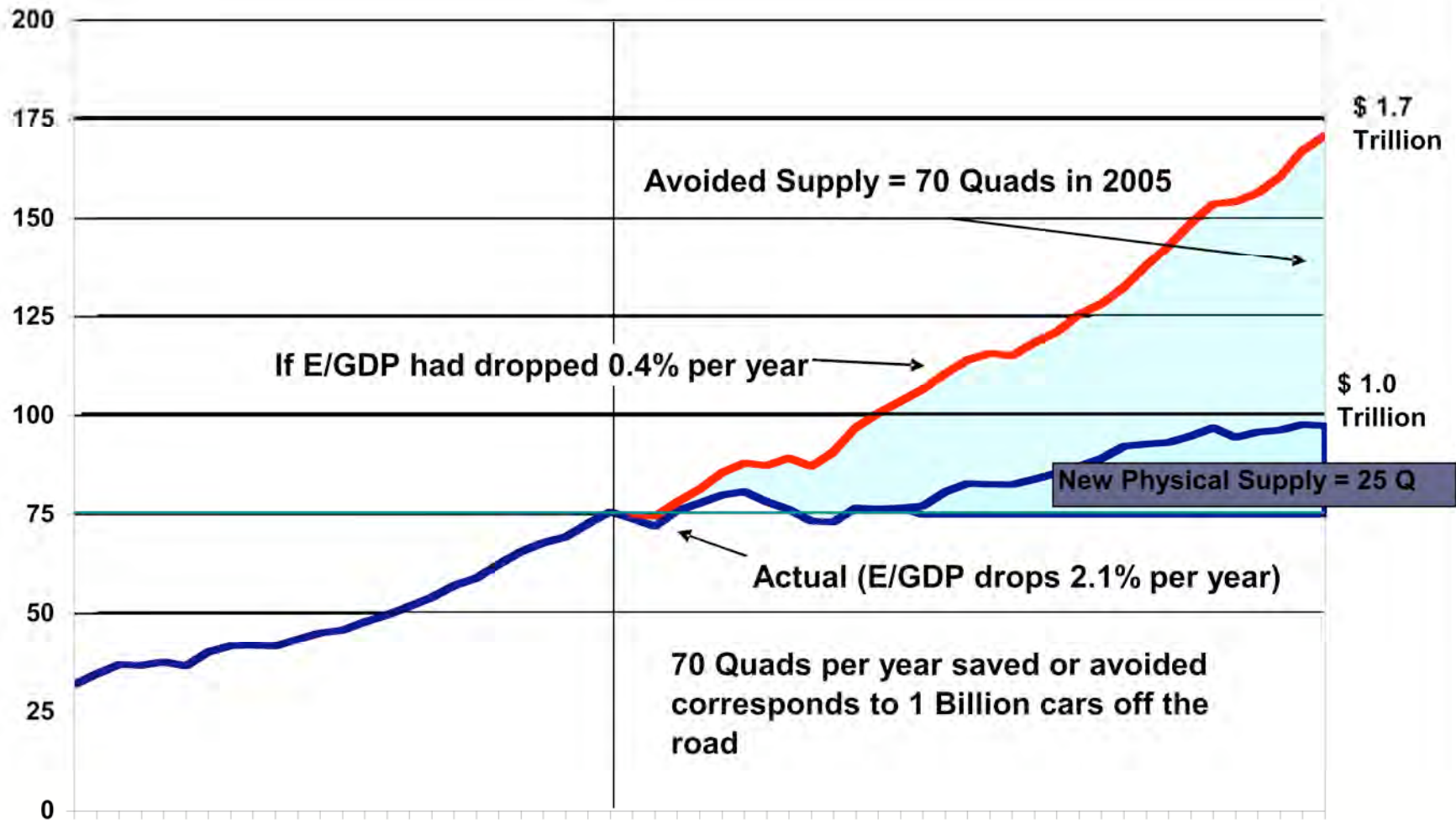
# Nuclear Physics

*A Course Given by* **ENRICO FERMI**  
*at the University of Chicago. Notes Compiled by*  
*Jay Orear, A. H. Rosenfeld, and R. A. Schluter*

## Energy Intensity in the United States 1949 - 2005



## Energy Consumption in the United States 1949 - 2005



# How Much of The Savings Come from Efficiency?

- ◆ Easiest to tease out is cars
  - In the early 1970s, only 14 miles per gallons
  - Now about 21 miles per gallon
  - If still at 14 mpg, we'd consume **75 billion gallons more** and pay **~\$200 Billion more** at 2006 prices
  - But we still pay **\$450 Billion per year**
  - If California wins the “Schwarzenegger-Pavley” suit, and it is implemented nationwide, we'll save **another \$150 Billion per year**
- ◆ Commercial Aviation improvements save another **\$50 Billion per year**
- ◆ Appliances and Buildings are more complex
  - We must sort out true efficiency gains vs. structural changes (from smokestack to service economy).

## How Much of The Savings Come from Efficiency (cont'd)?

- ◆ Some examples of estimated savings in 2006 based on 1974 efficiencies minus 2006 efficiencies

	Billion \$
Space Heating	40
Air Conditioning	30
Refrigerators	15
Fluorescent Tube Lamps	5
Compact Fluorescent Lamps	5
<b>Total</b>	<b>95</b>

- ◆ Beginning in 2007 in California, reduction of “vampire” or stand-by losses
  - This will save \$10 Billion when finally implemented, nation-wide
- ◆ Out of a total **\$700 Billion**, a crude summary is that 1/3 is structural, 1/3 is transportation, and 1/3 is buildings and industry.

## A supporting analysis on the topic of efficiency from Vice-President Dick Cheney

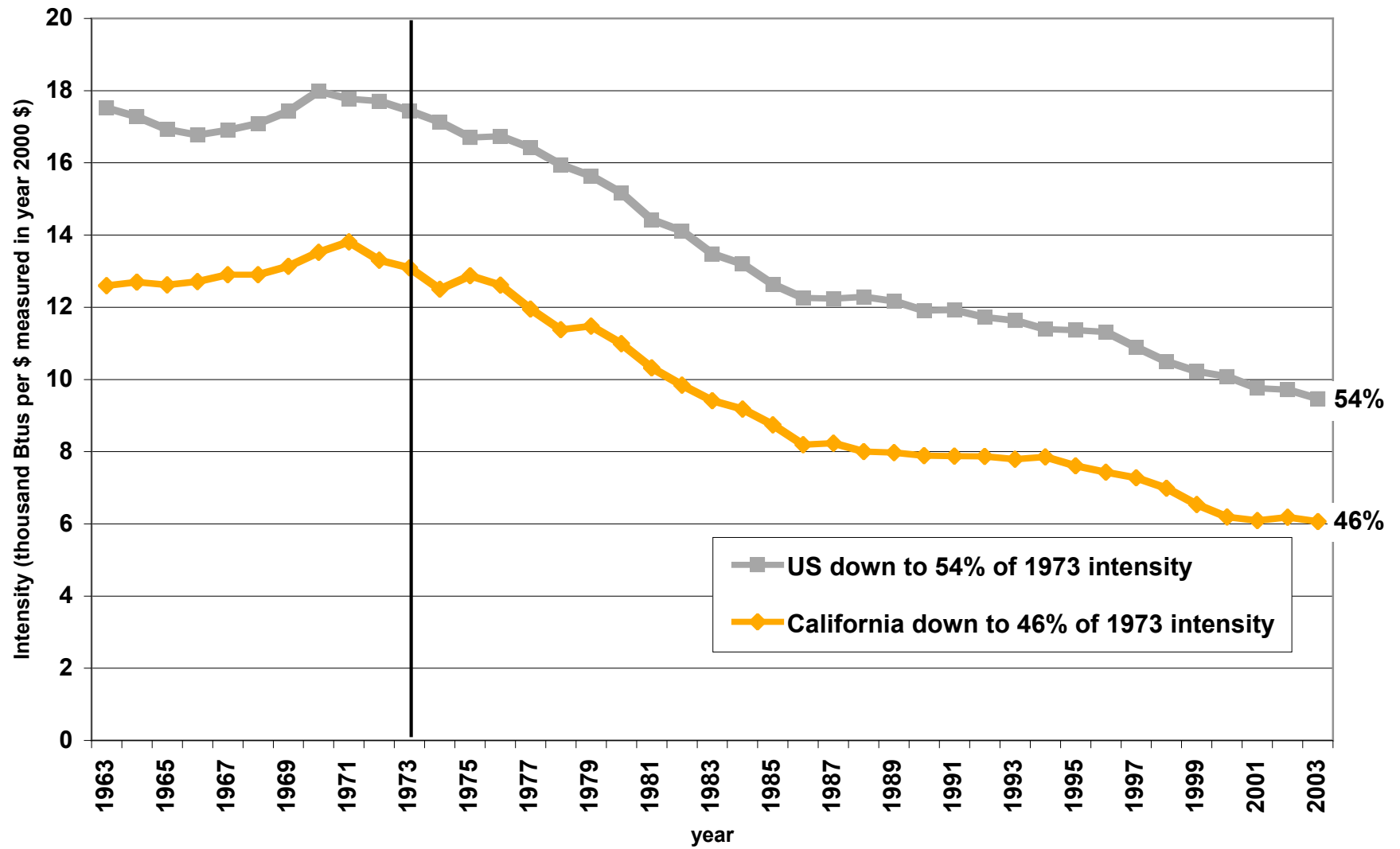
- ◆ “Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus”
- ◆ “About a third to a half of these savings resulted from shifts in the economy. The other half to two-thirds resulted from greater energy efficiency”

*Source: National Energy Policy: Report of the National Energy Policy Development Group, Dick Cheney, et. al., page 1-4, May 2001*

**Cheney could have noted that 72 quads/year saved in the US alone, would fuel one Billion cars, compared to a world car count of only 600 Million**

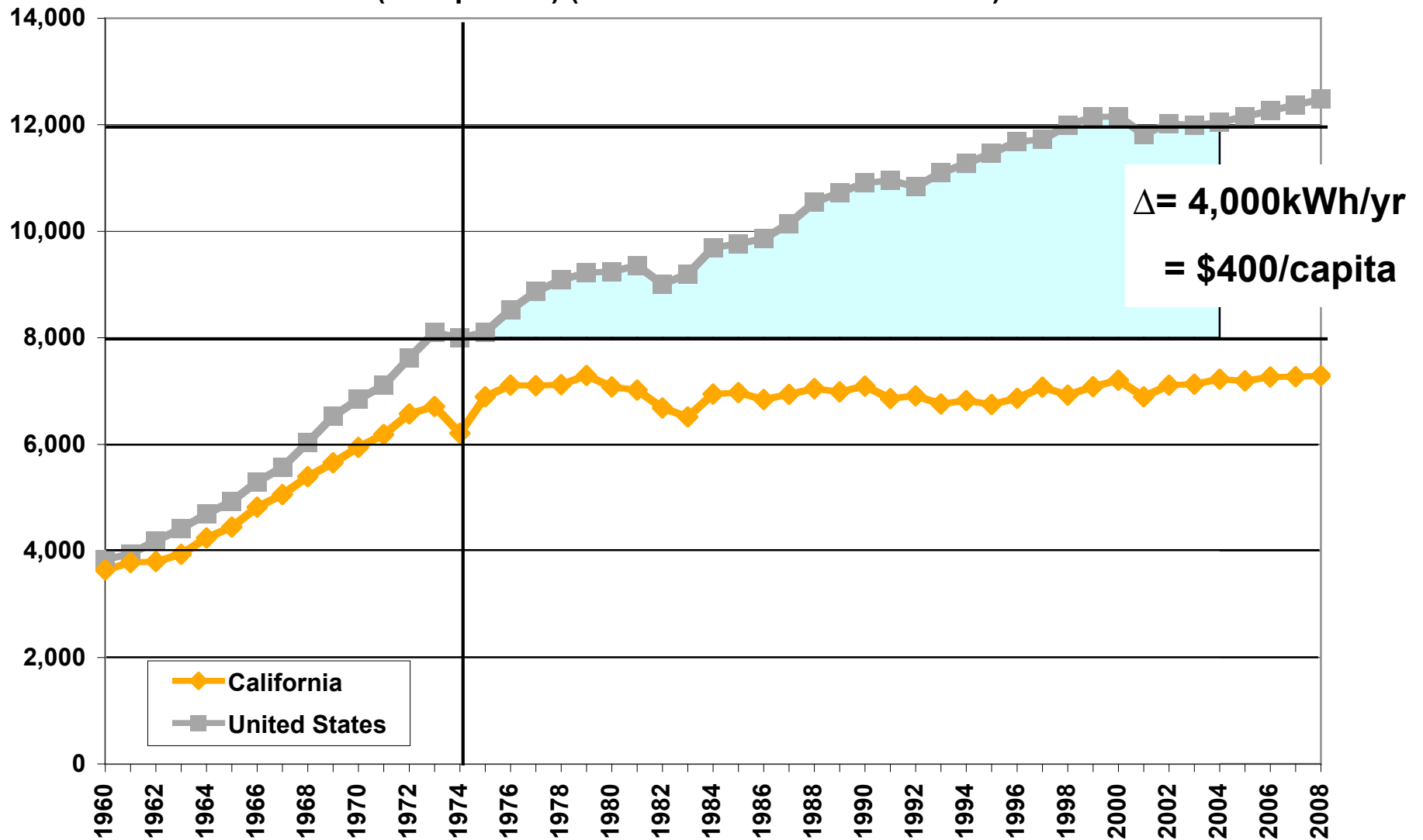


Energy Intensity -- California and the United States

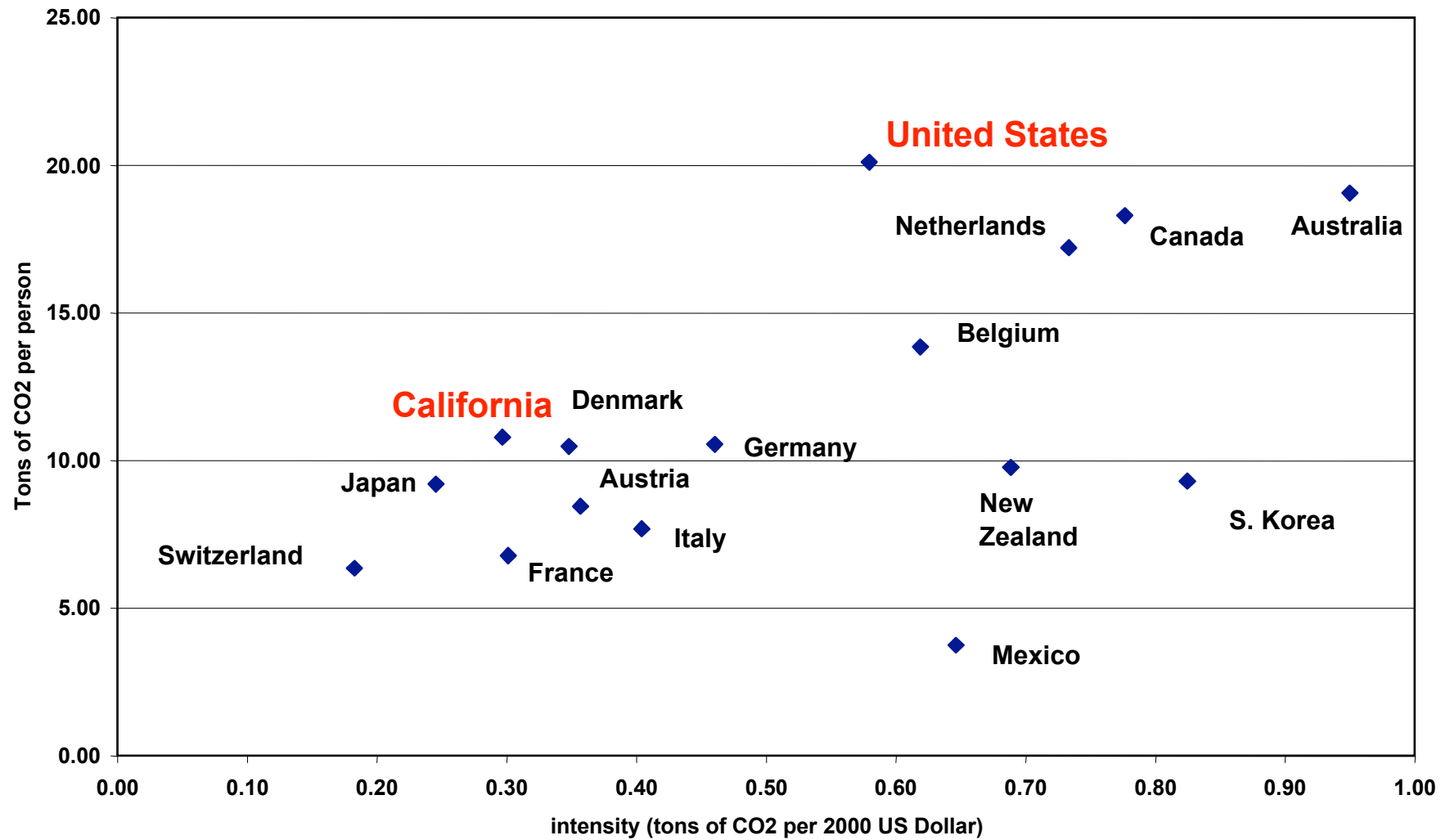




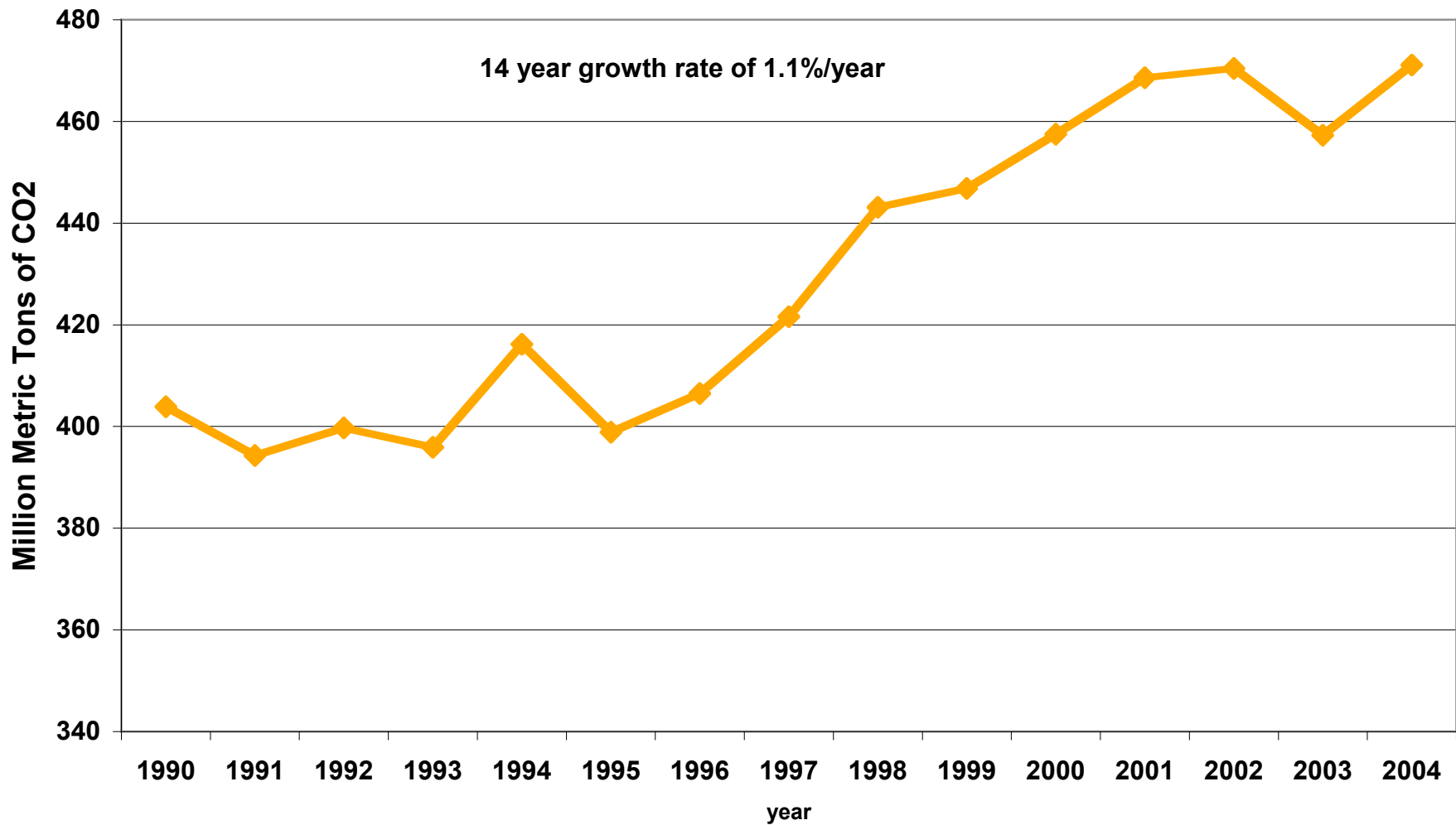
Per Capita Electricity Sales (not including self-generation)  
(kWh/person) (2005 to 2008 are forecast data)



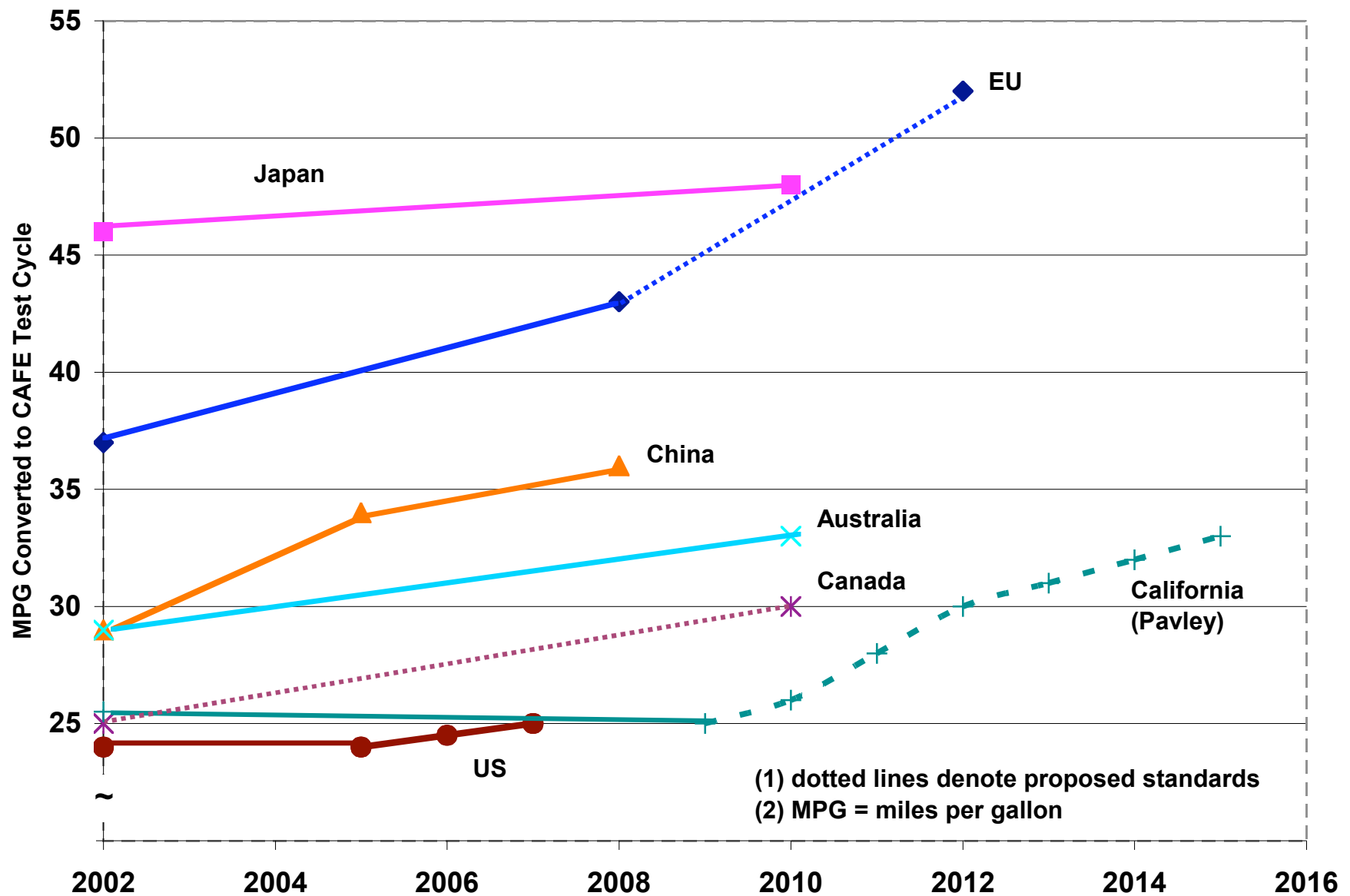
Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001  
(Fossil Fuel Combustion Only)



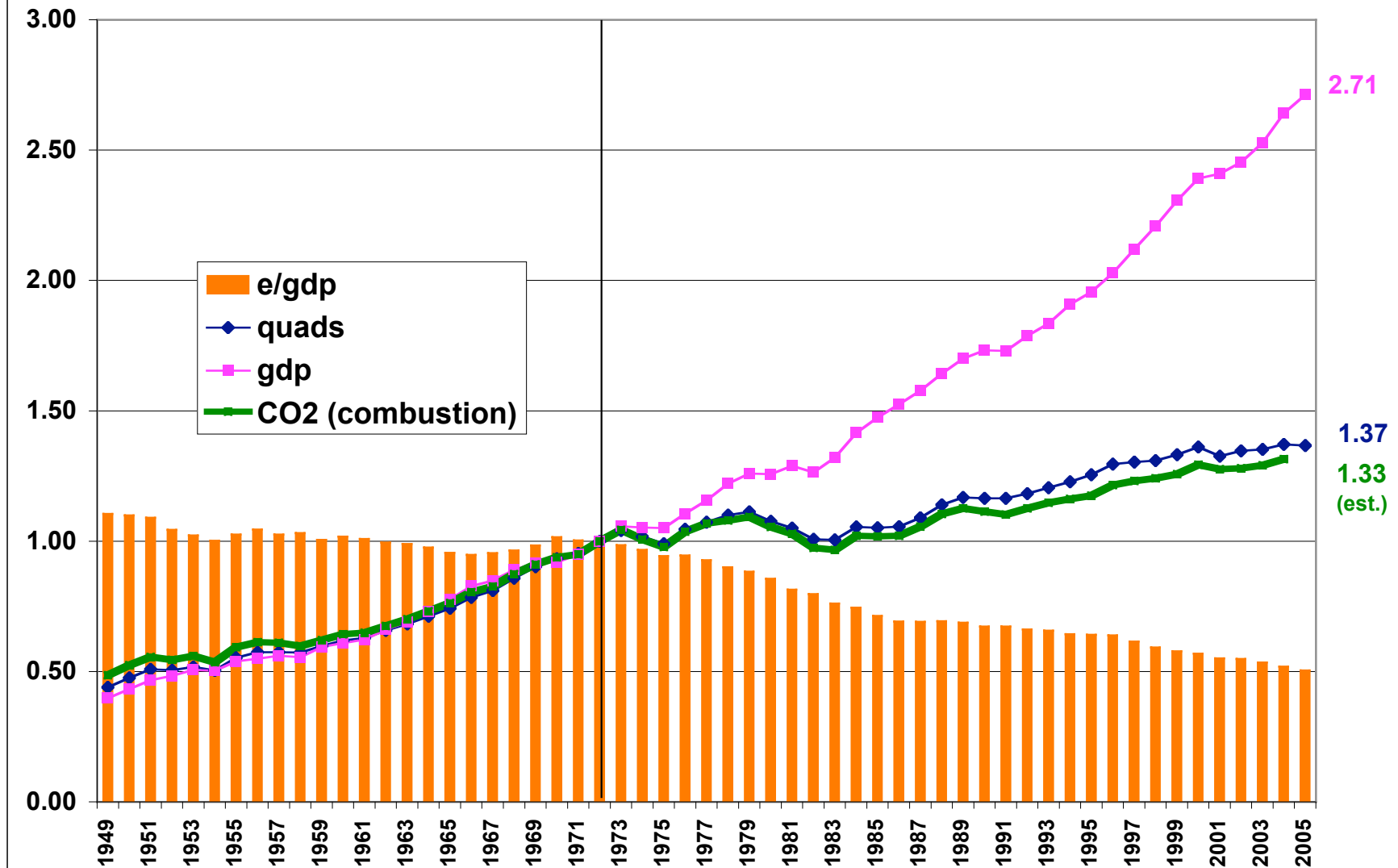
## CO2 Emissions in California Including Electricity Imports 1990 - 2004



## Comparison of Fuel Economy – Passenger Vehicles

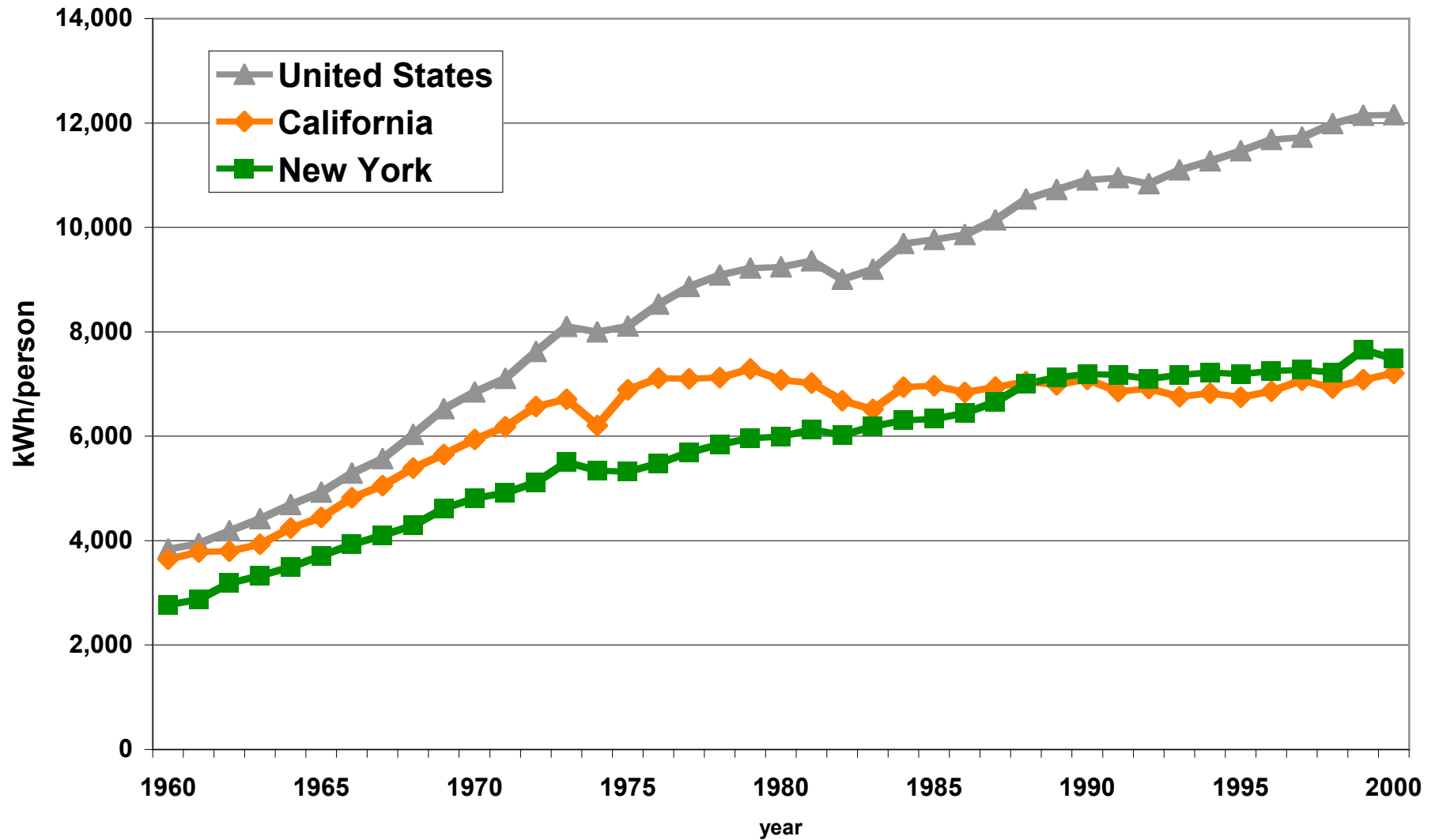


Index (1972 = 1.00) of U.S. Energy Use, GDP, Energy Intensity and Carbon Dioxide  
last 10-year CO2 growth = 1.3% per year

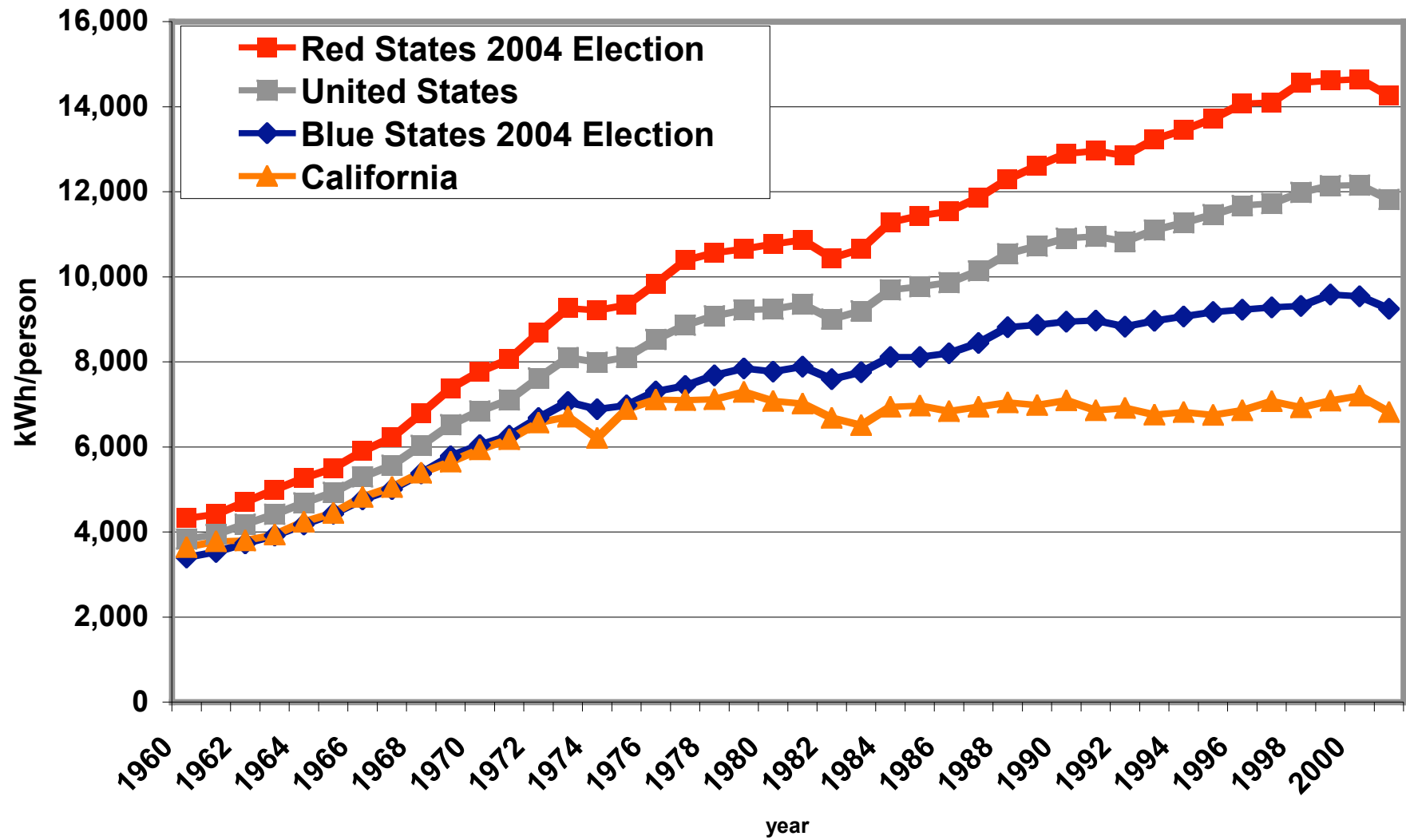


## Per Capita Electricity Consumption

Source: [http://www.eia.doe.gov/emeu/states/sep\\_use/total/csv/use\\_csv](http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv)

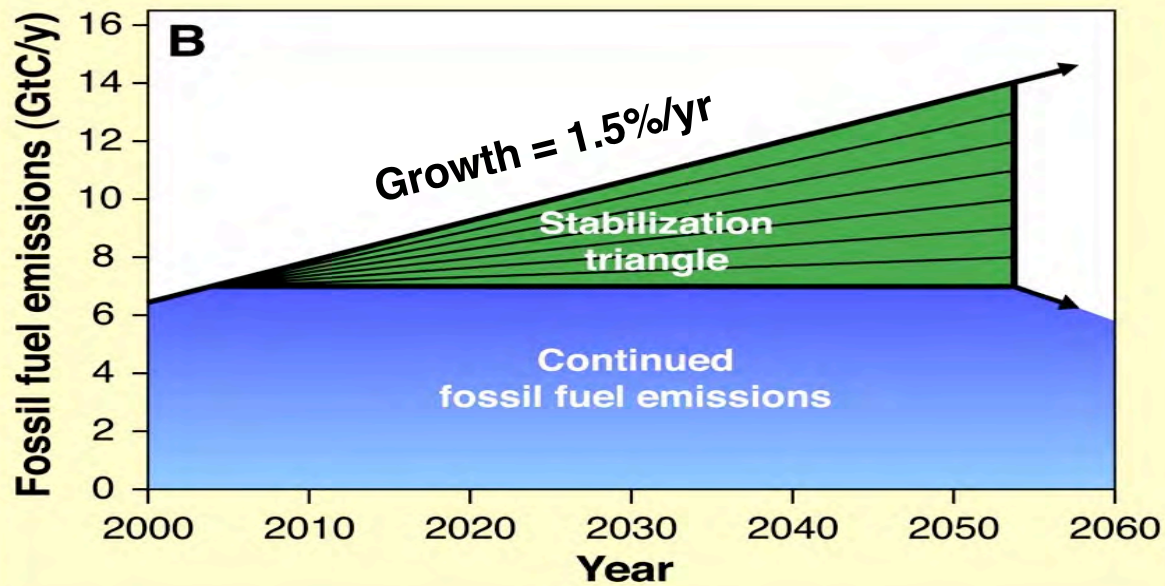
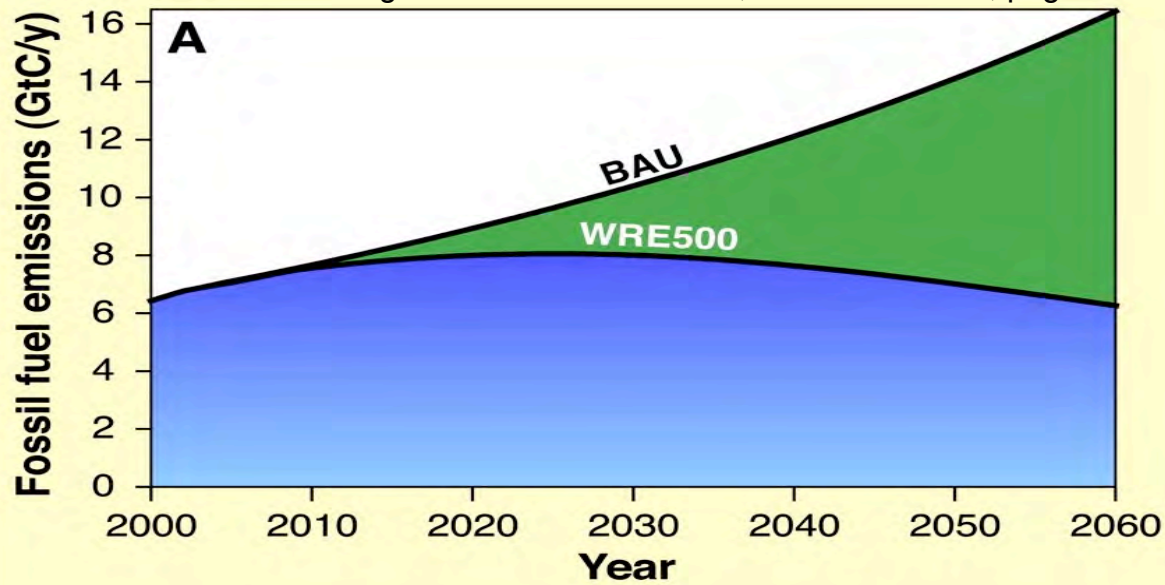


### Per Capita Electricity Consumption

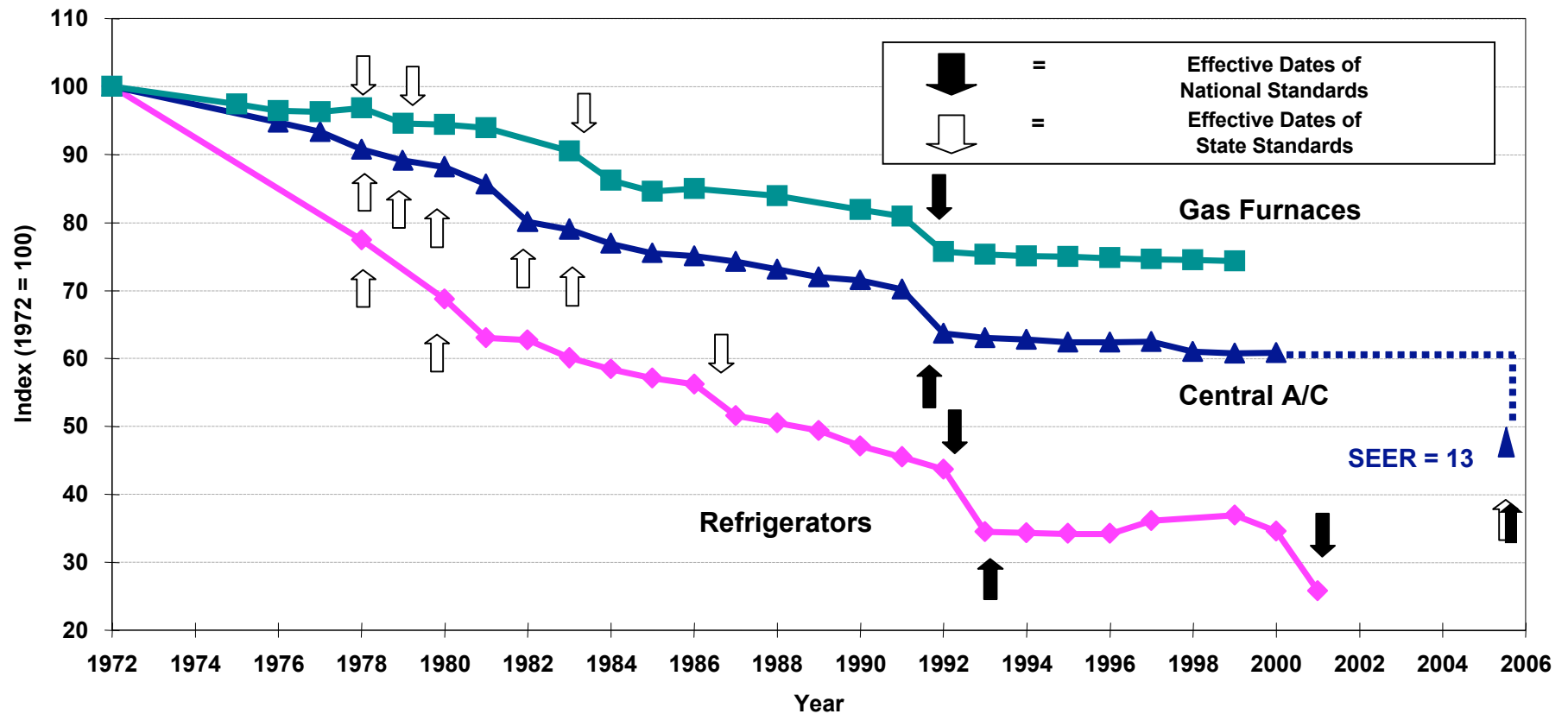




Source: Stabilization Wedges: Pacala and Socolow, Science Vol 305, page 968

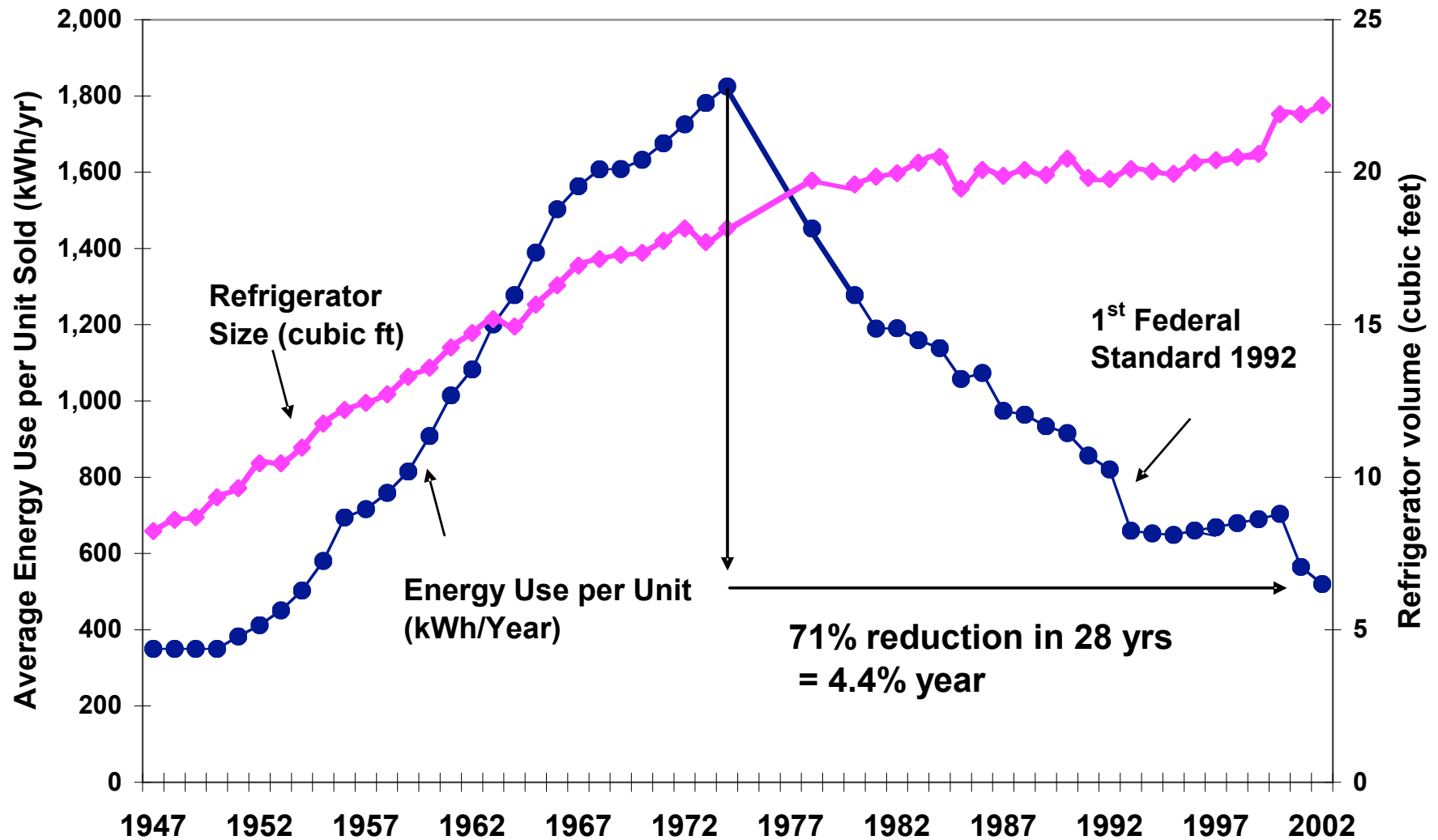


# Impact of Standards on Efficiency of 3 Appliances

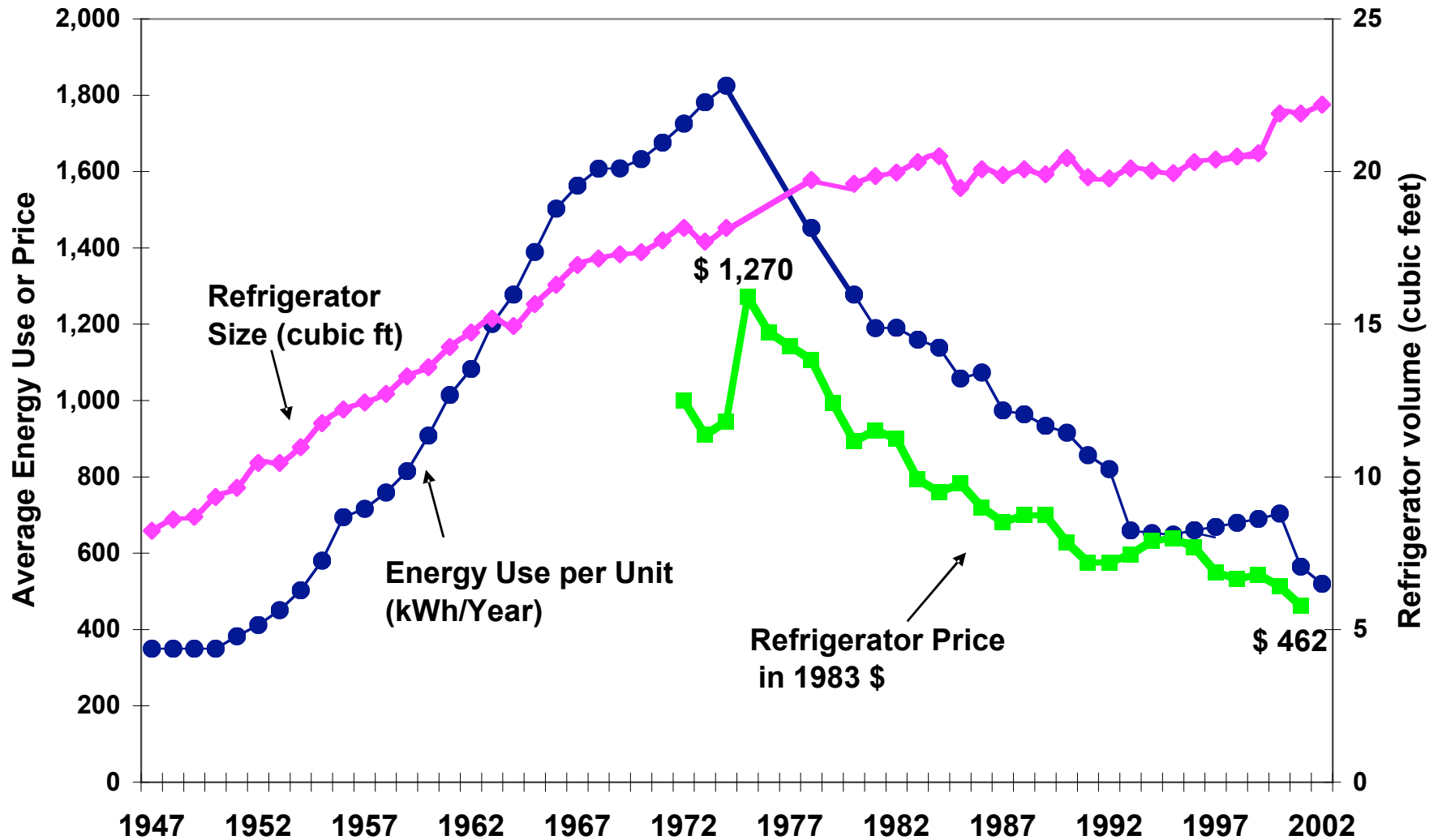


Source: S. Nadel, ACEEE,  
in ECEEE 2003 Summer Study, [www.eceee.org](http://www.eceee.org)

## New United States Refrigerator Use v. Time

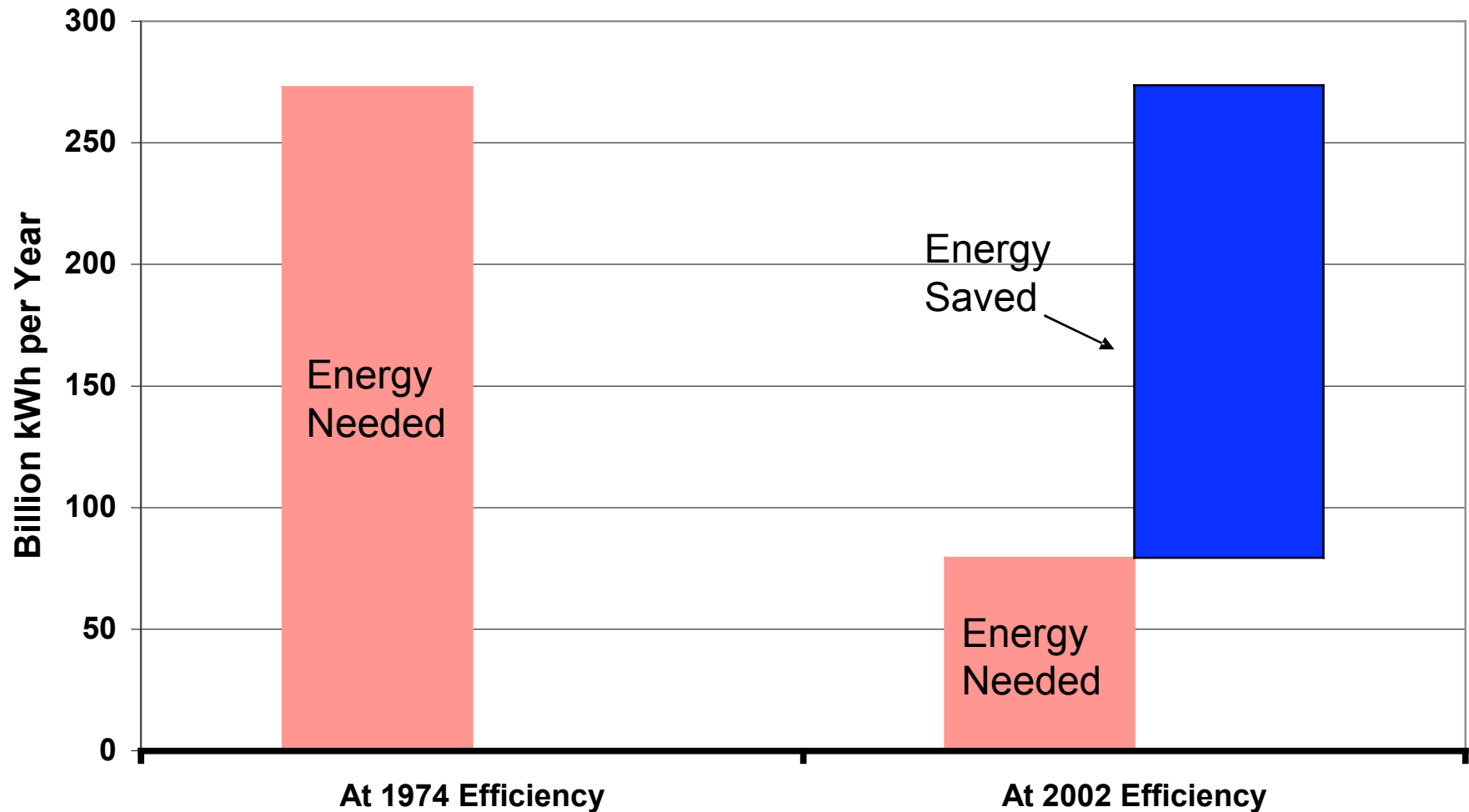


## New United States Refrigerator Use v. Time and Retail Prices

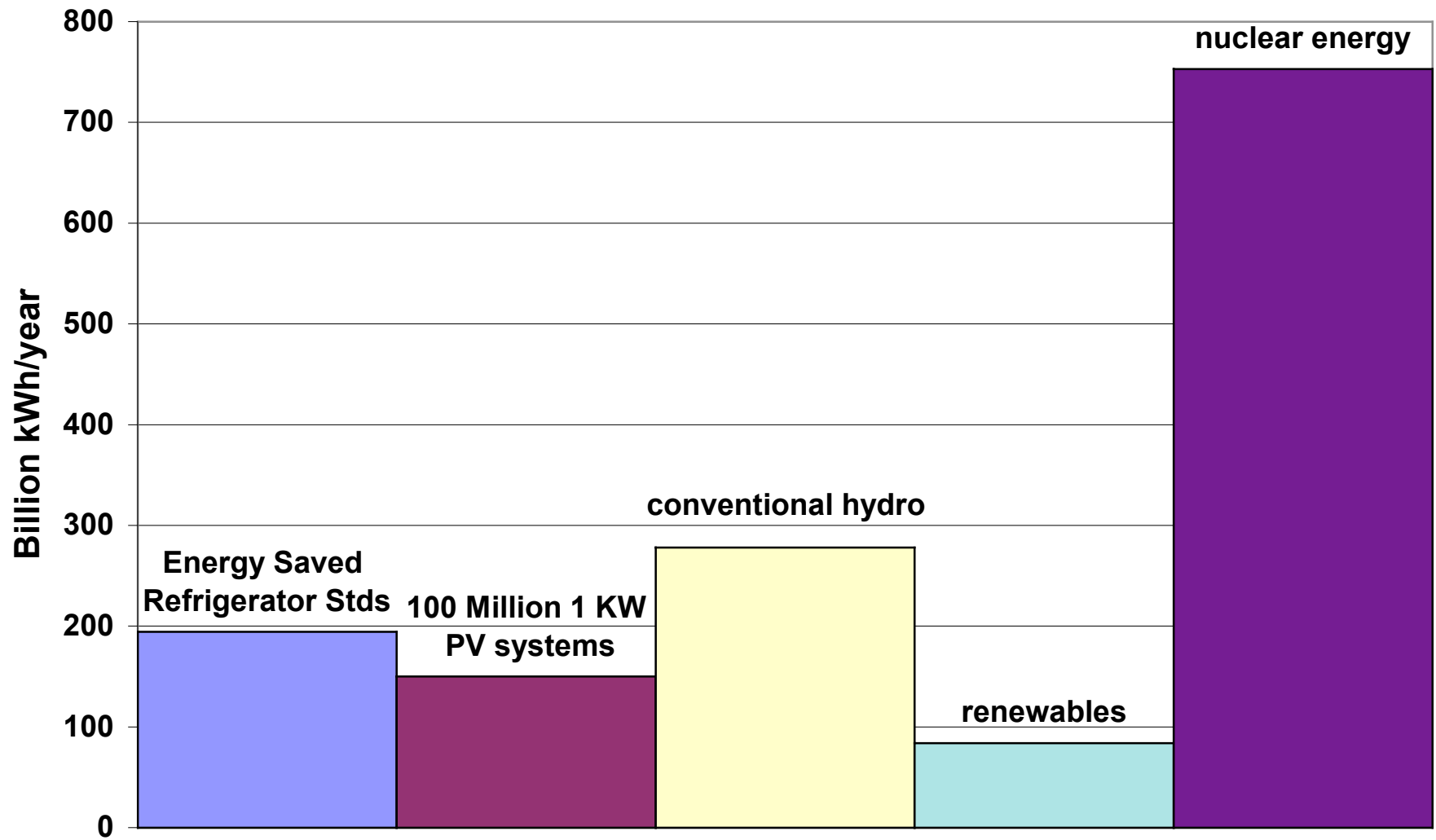


Source: David Goldstein

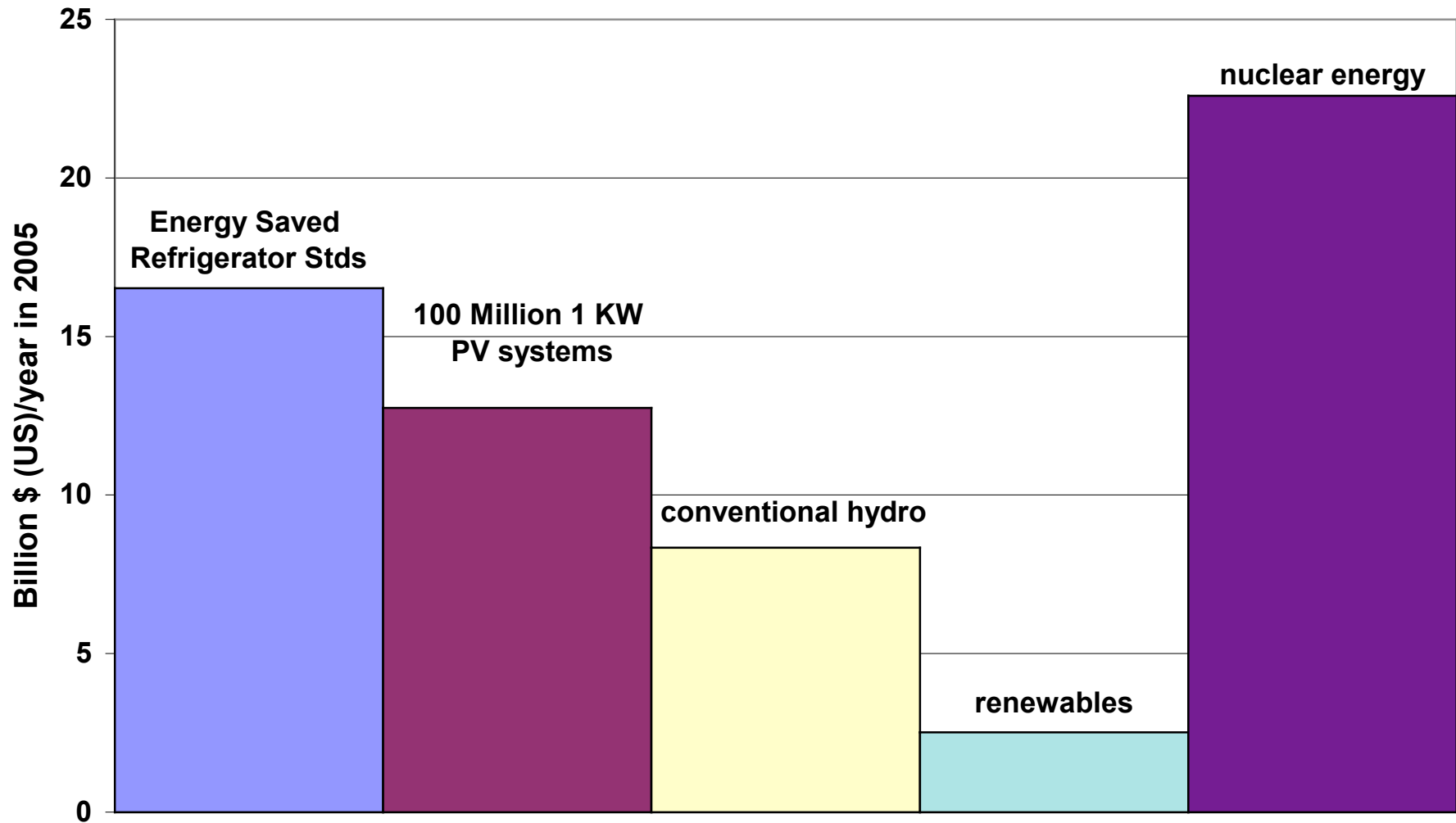
**New Refrigerator Energy Use: 71% will be saved when stock completely turns over to 2001 Standards**



## Annual Energy Saved vs. Several Sources of Supply

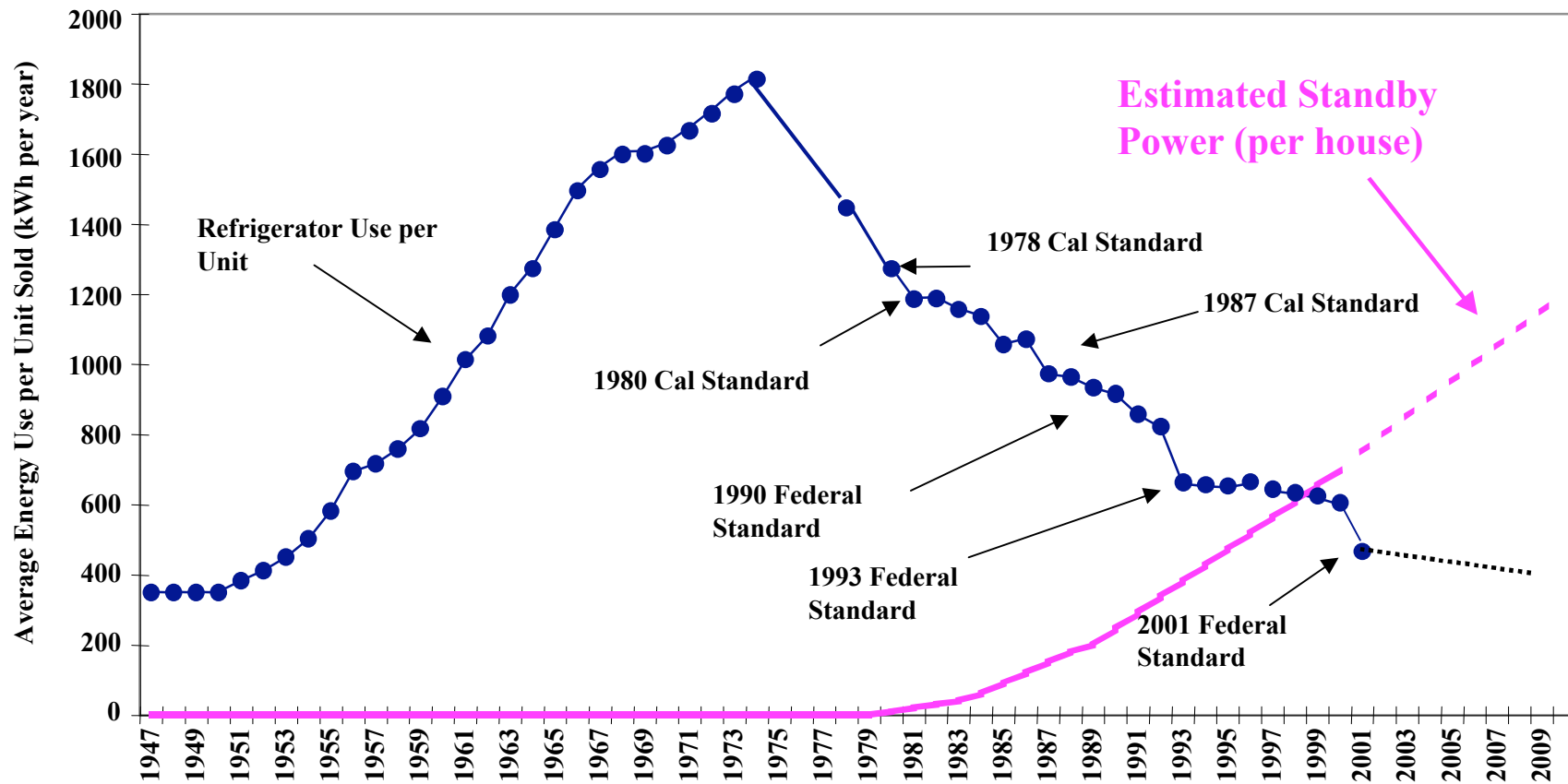


**Value of Energy to be Saved (at 8.5 cents/kWh, retail price) vs.  
Several Sources of Supply in 2005 (at 3 cents/kWh, wholesale price)**



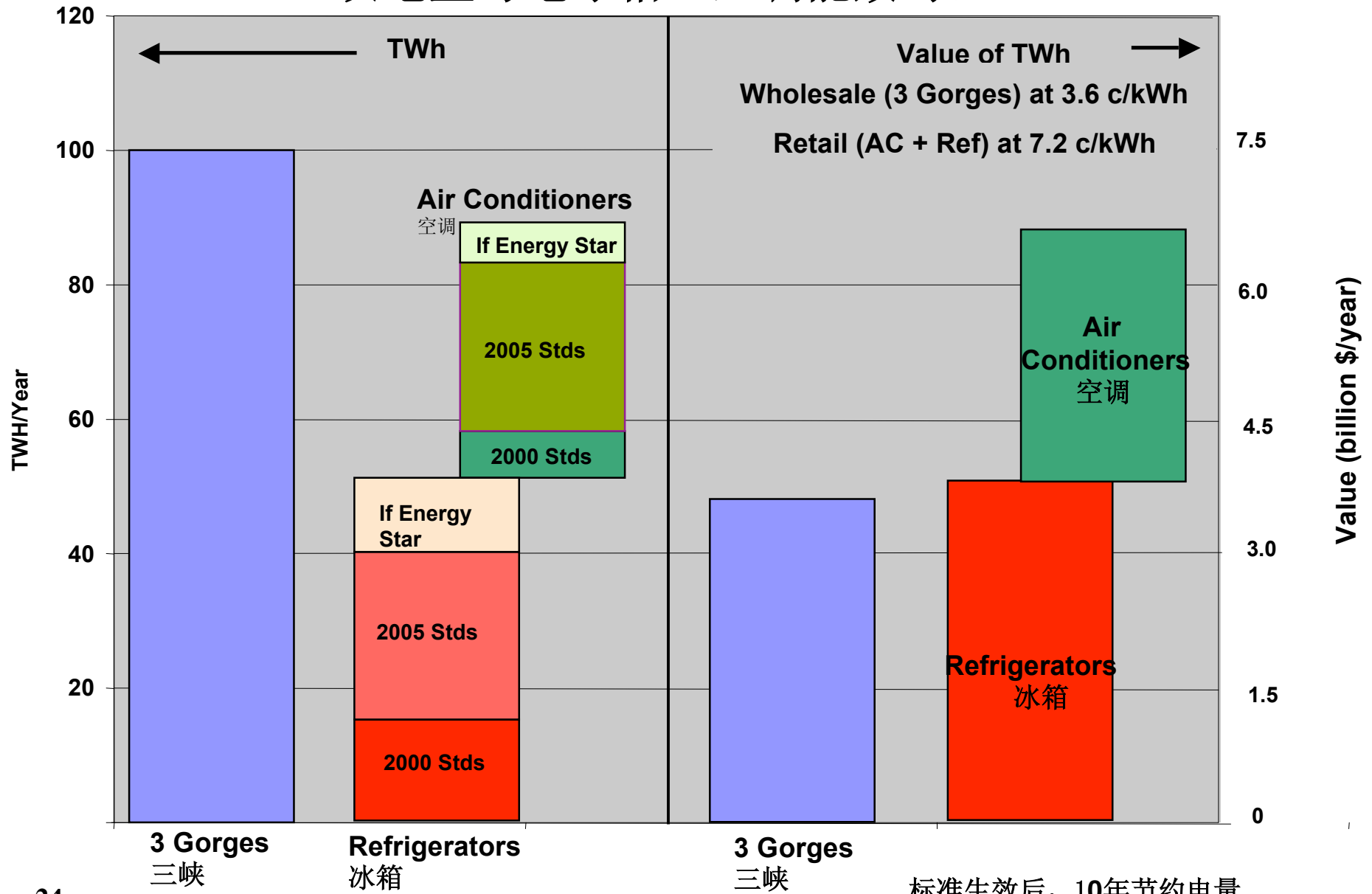


## United States Refrigerator Use, repeated, to compare with Estimated Household Standby Use v. Time



# Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

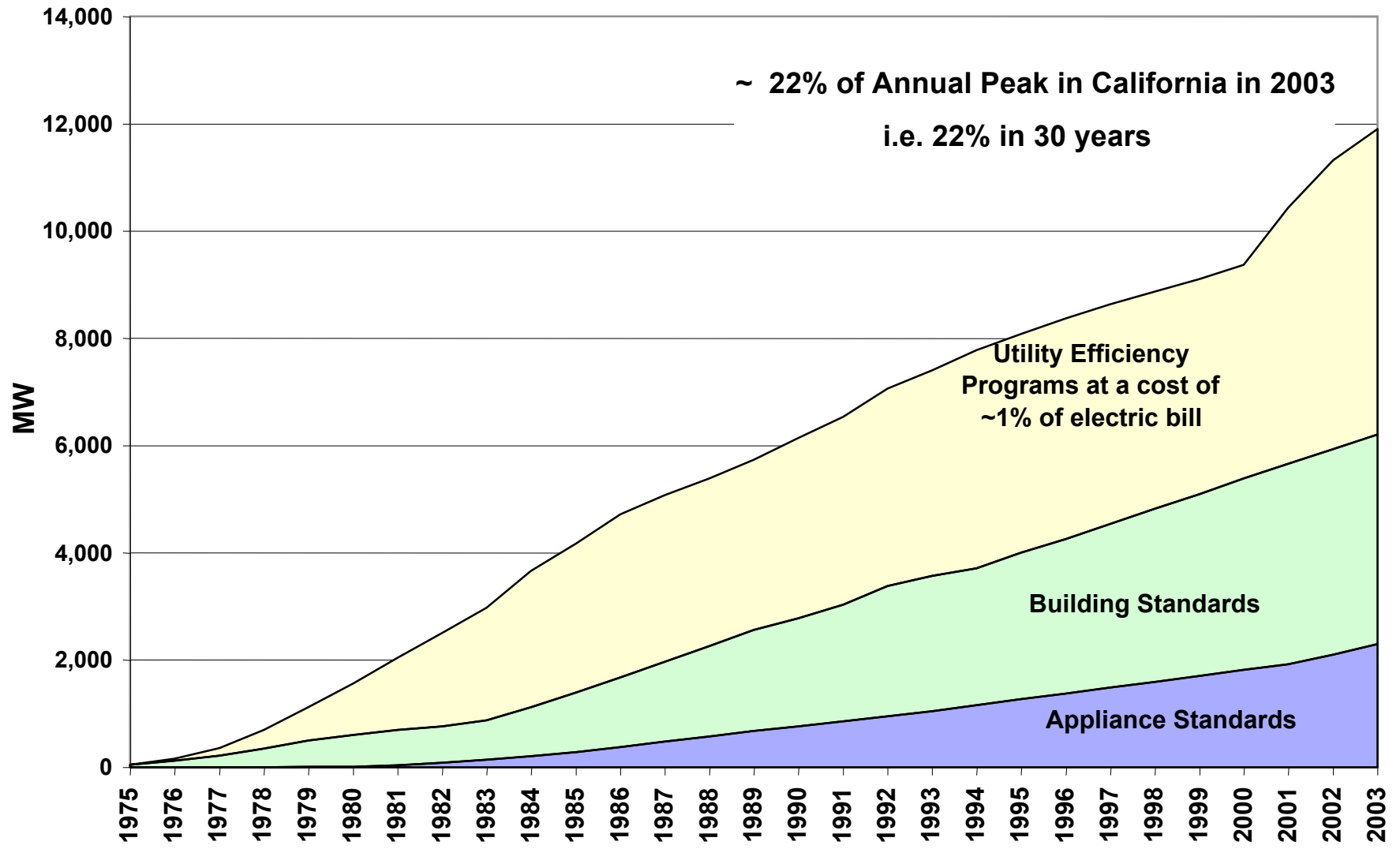
## 三峡电量与电冰箱、空调能效对比



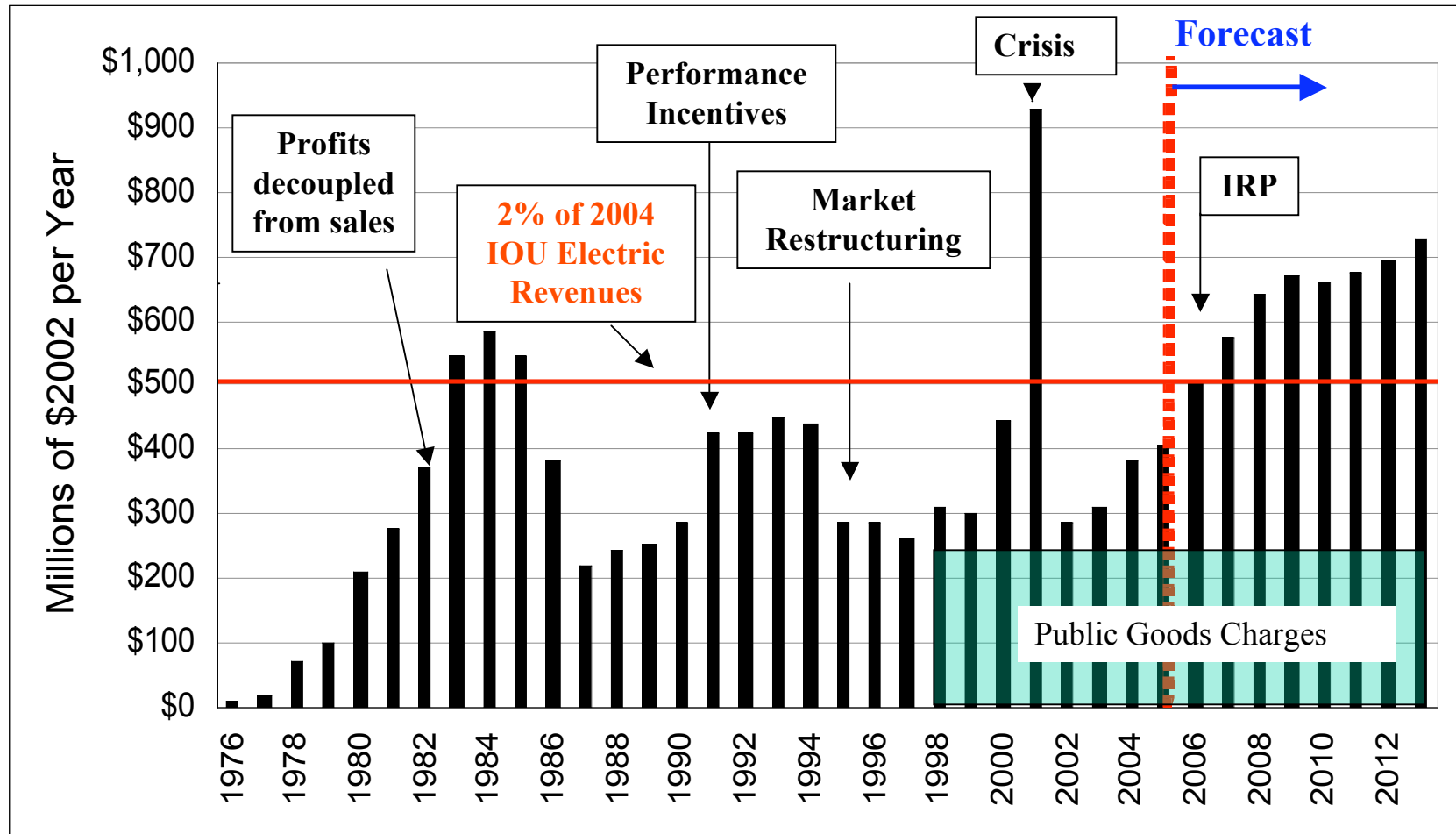
Savings calculated 10 years after standard takes effect. Calculations provided by David Fridley, LBNL

标准生效后, 10年节约电量

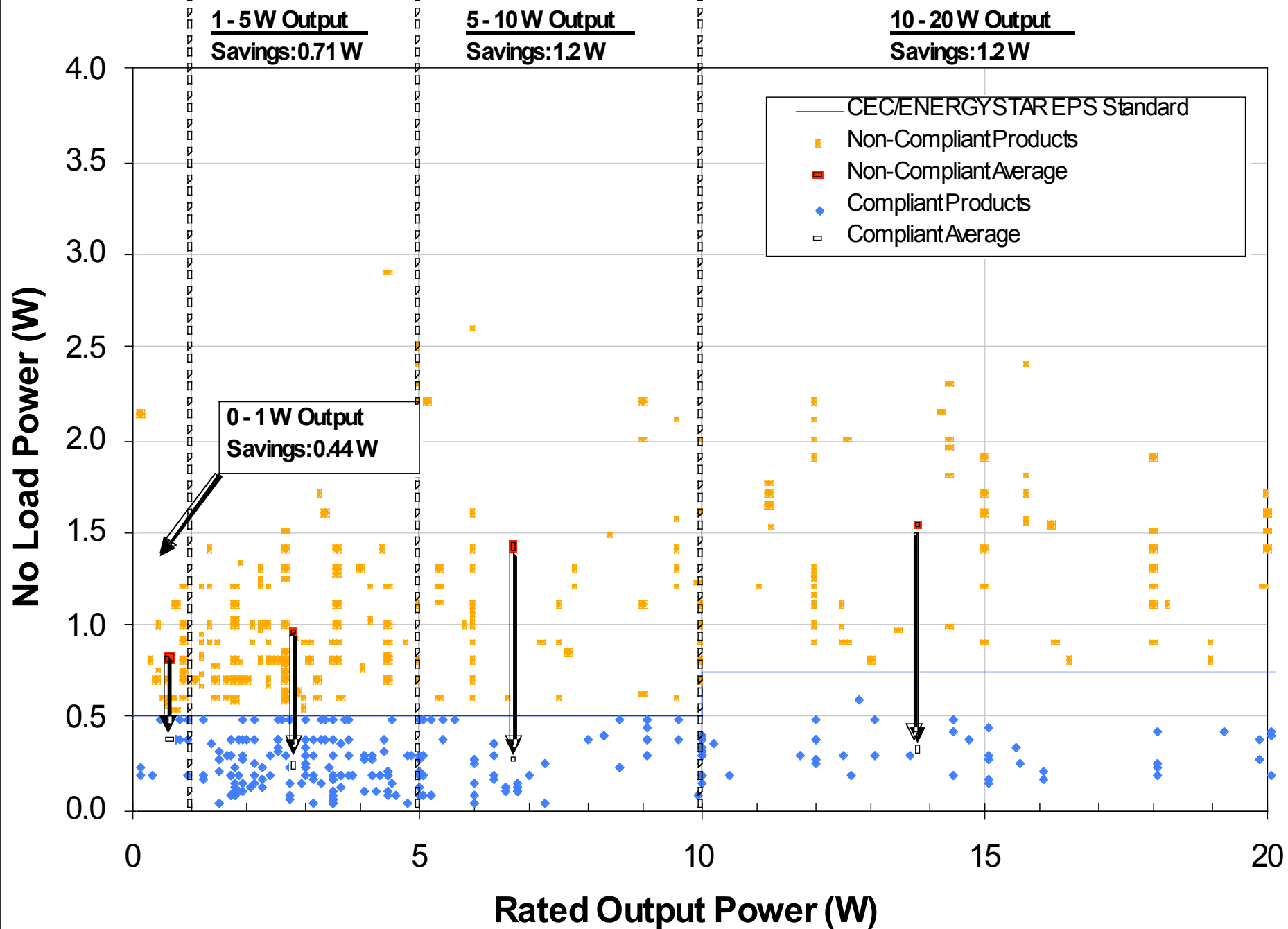
## Annual Peak Savings from Efficiency Programs and Standards



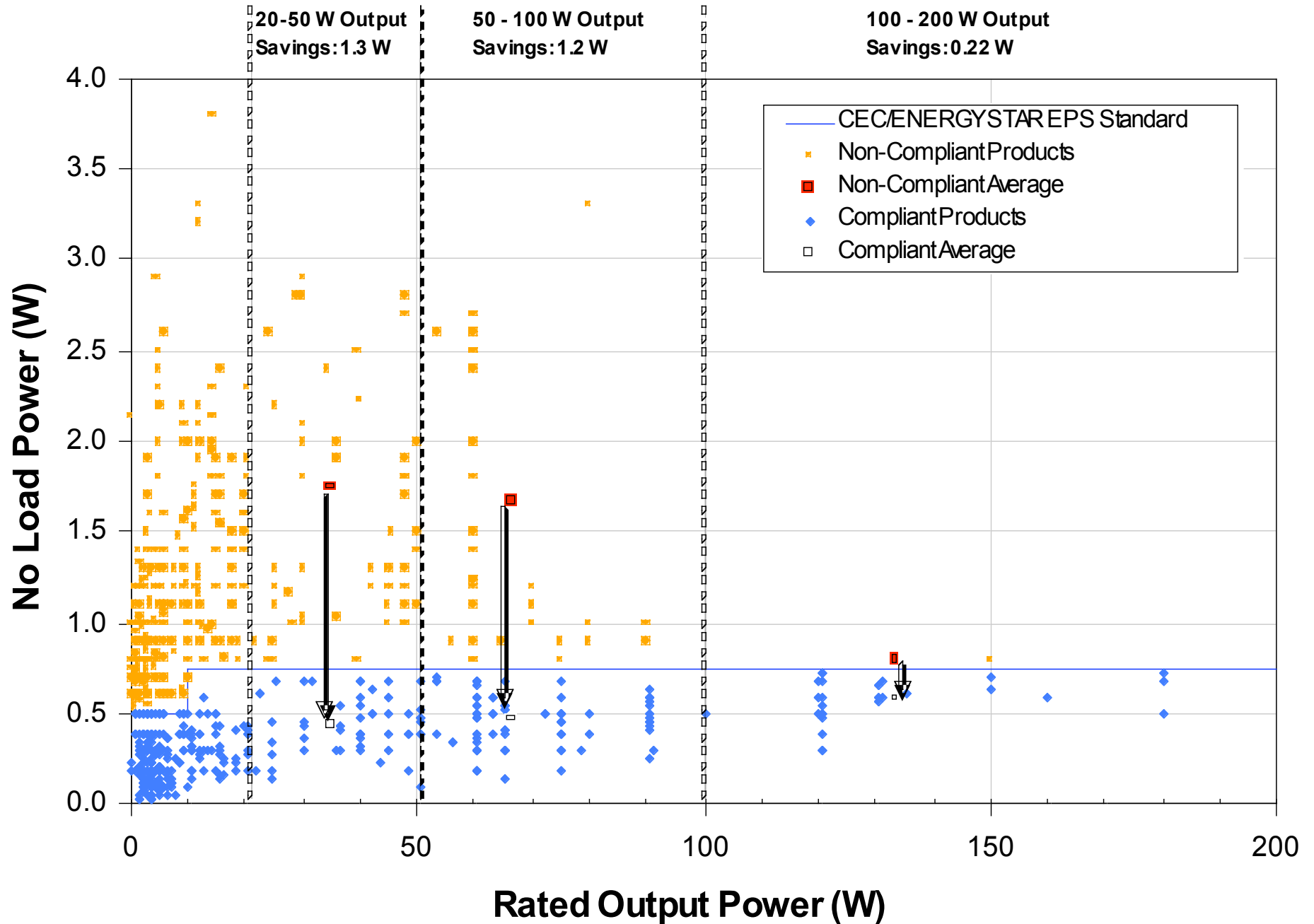
# California IOU's Investment in Energy Efficiency



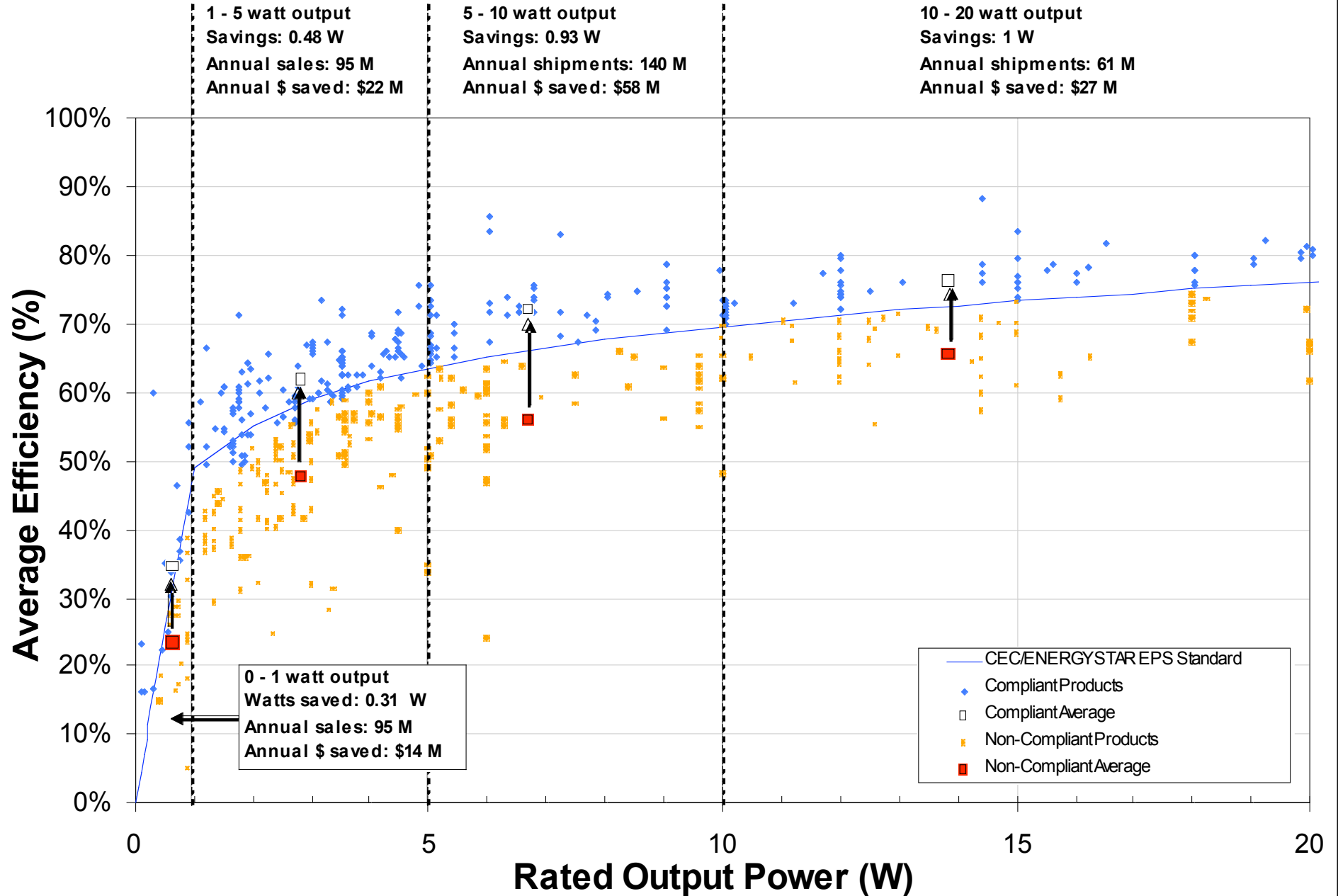
## No Load Efficiency Improvements (< 20 W)



## No Load Efficiency Improvements (< 200 W)

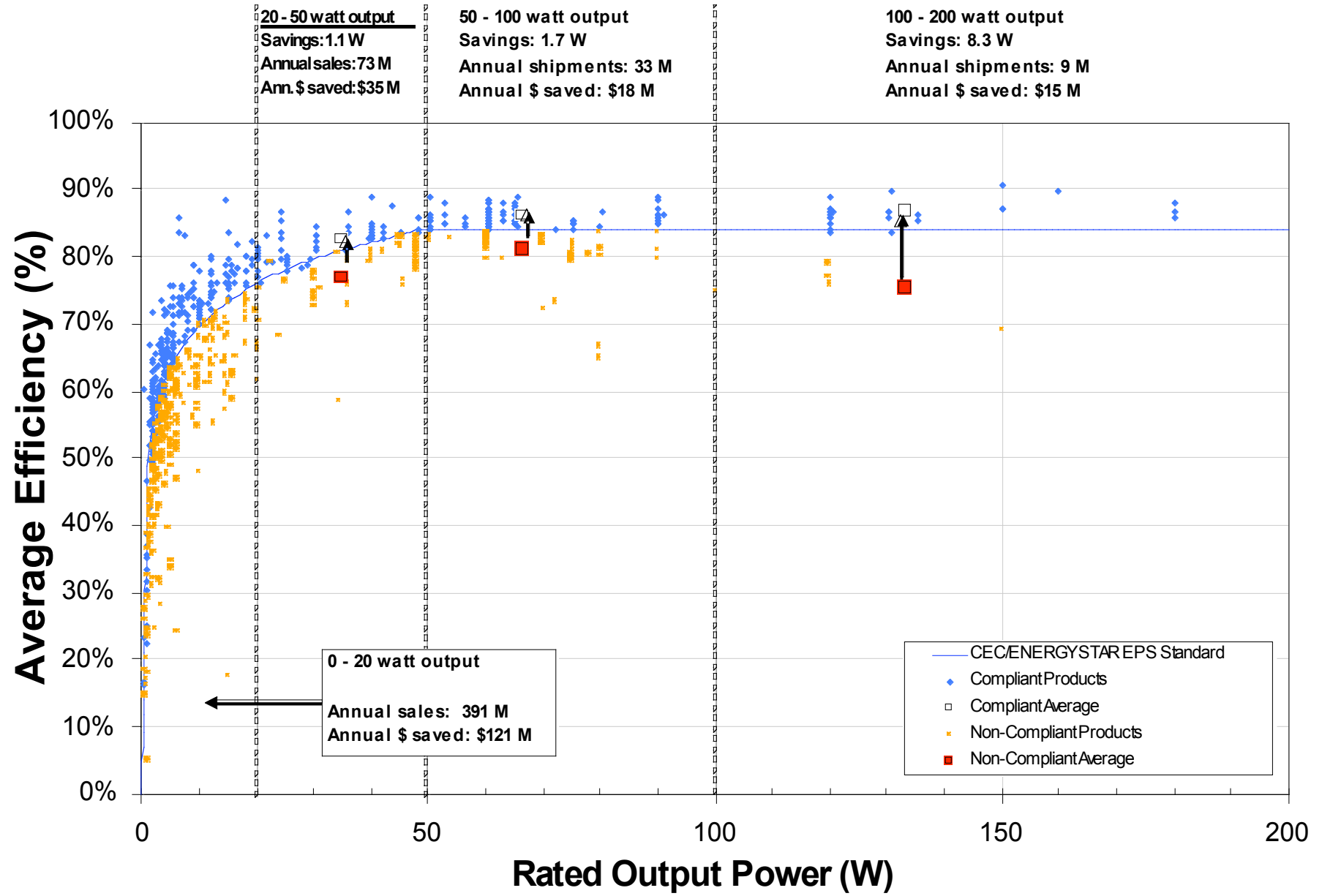


## Active Mode Efficiency Improvements (< 20 W output)





## Active Mode Efficiency Improvements (< 200 W output)



<sup>30</sup>Standards for EPS will eventually result in \$189 million per year in national electricity savings

# EPS Energy Savings Impact

US savings year 1: \$189 M or 1.9 billion kWh, about half from no-load, half from active mode.

- ◆ By the 5<sup>th</sup> year (including growth), we will be saving annually \$1 B or 10 BkWh
- ◆ This is the equivalent annual output of 4 typical 500-MW power plants, or taking 1 million cars off the road.
- ◆ Payback time (SPT)— No-load, 1 mo. or Zero; Active mode, ~1 year.

## **Electronics Research funded by CEC/PIER leading to developing California Standards. 1– at Ecos Consulting**

### **Topics:**

- External and internal ac-dc power supplies
- Dc-dc power supplies; many of them, tiny but inefficient.
- Battery-charging supplies; standards work starts late '07.
- Computers, servers, data centers
- Televisions, set top boxes and other consumer electronics; develop test procedures
- Plug load studies

### **Information:**

[www.EfficientPowerSupplies.org](http://www.EfficientPowerSupplies.org) [www.EfficientProducts.org](http://www.EfficientProducts.org)

### **Contact:**

- Chris Calwell - [ccalwell@ecosconsulting.com](mailto:ccalwell@ecosconsulting.com)

# Electronics Research funded by CEC/PIER 2--- at Lawrence Berkeley National Lab

## ◆ Topics:

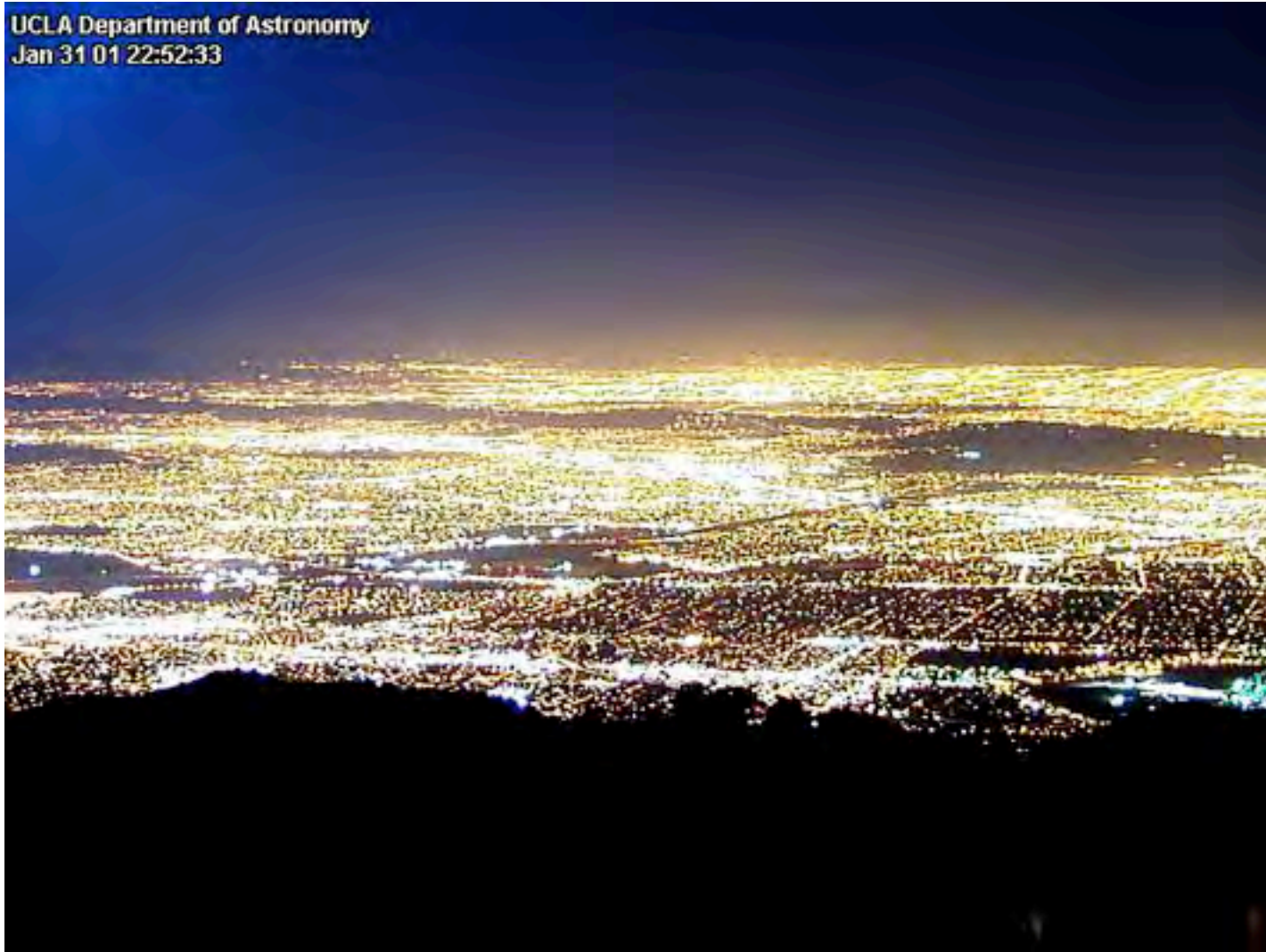
- Power-efficient Ethernet and FireWire links
- Reducing network-induced consumption
- Efficiency specs for network products
- Consumer electronics inter-device controls
- Efficient set-top boxes
- Reducing energy use of hard-wired and builder-installed equipment in new homes

## ◆ December 2006 to December 2008

## ◆ Contact:

- Bruce Nordman - [BNordman@lbl.gov](mailto:BNordman@lbl.gov)

UCLA Department of Astronomy  
Jan 31 01 22:52:33



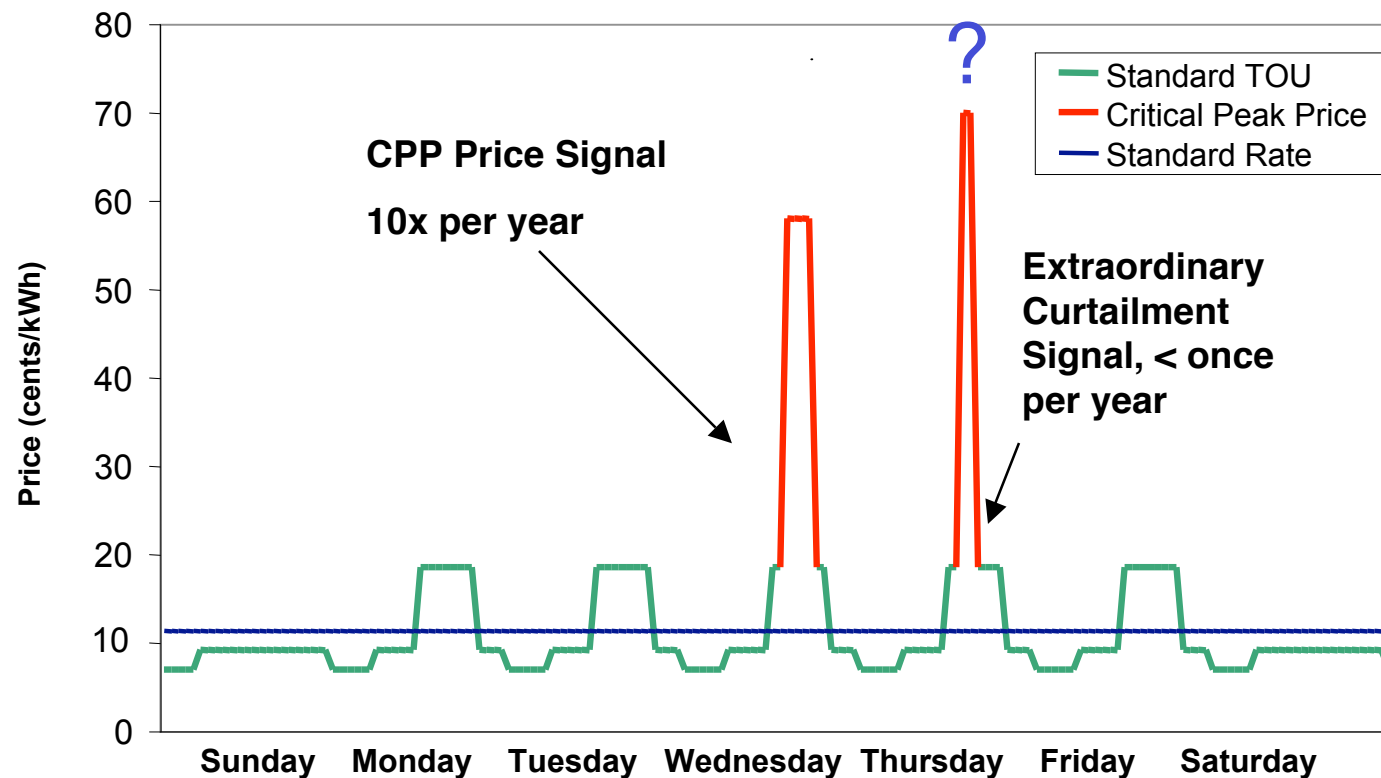
## Illuminating Space vs. the Street



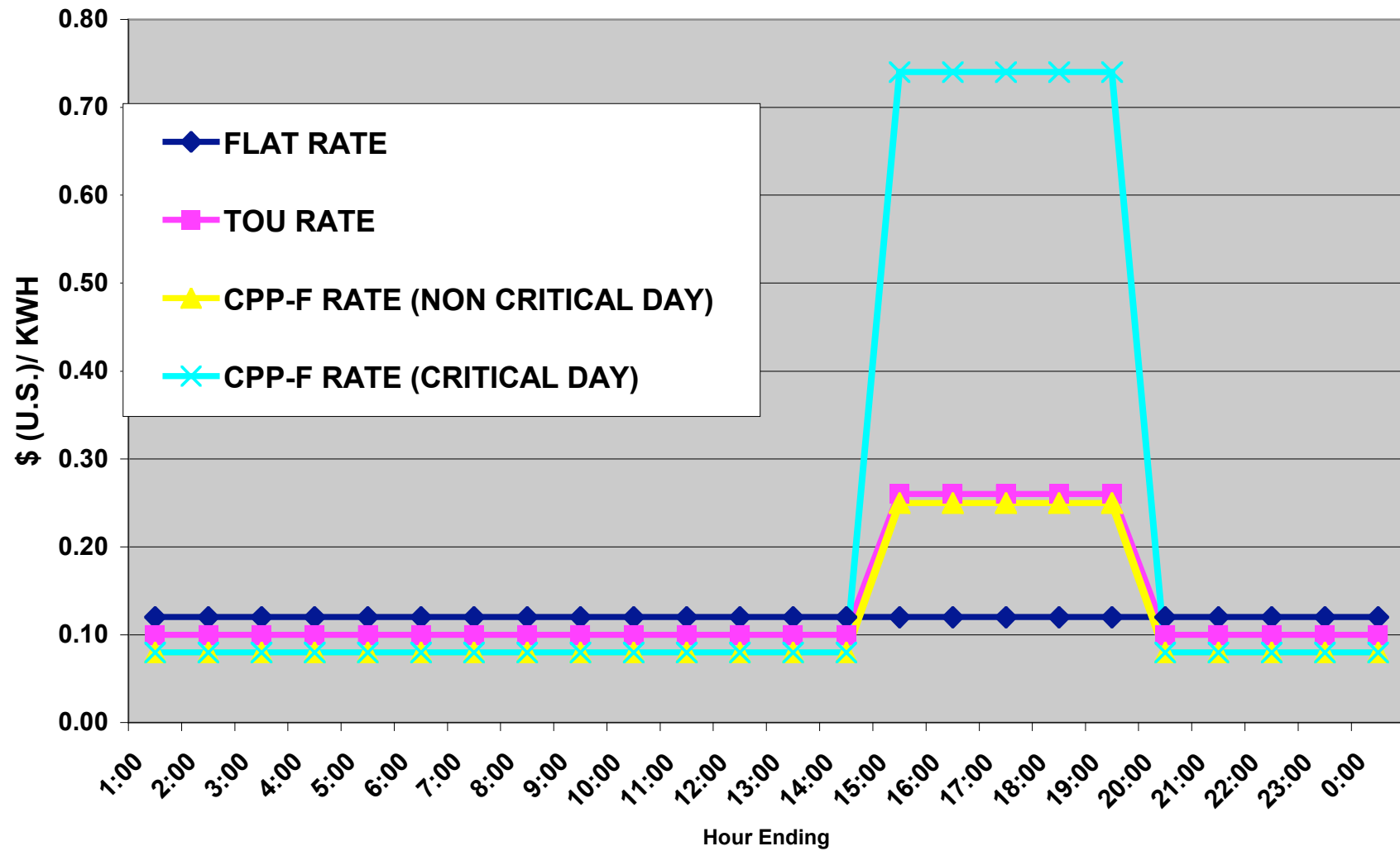
# Critical Peak Pricing (CPP) with additional curtailment option

## Potential Annual Customer Savings:

10 afternoons x 4 hours x 1kw = 40 kWh at 70 cents/kWh = ~\$30/year



## Tariffs being Tested in California Pilot





## AutoDR - Results

Company	Avg kW Savings	Avg % Savings	Max kW Saving	events (2003-4/2005)	Setup Cost
ACWD	52	20%	84	4 (0)	\$12,824
B of A	111	2%	227	3 (4)	\$1,614
Chabot	18	5%	46	3 (1)	\$4,510
50 Douglas	61	21%	85	4 (4)	\$2,000
2530 Arnold	61	16%	92	1 (3)	\$2,000
Echelon	78	25%	110	4 (3)	\$3,620
Gilead	71	10%	208	4 (1)	\$7,500
IKEA	219	12%	272	2 (0)	\$5,050
Oracle	45	10%	65	1 (0)	\$375
Target	33	10%	56	4 (1)	\$3,312
USPS	202	15%	265	0 (2)	\$12,000

**Summary**      **951**      **13.4%**      **\$57.62 / kW \***

\* Note: Average setup cost for AC load control is approximately \$250.00 / kW

# Small Customer Demand Response, Retail Pricing Pilot, and Advanced Metering Infrastructure

- ◆ CPUC and CEC have been testing the impact of “CPP” (Critical Peak Pricing) on demand
  - Two summers of tests (\$10 M experiment).
- ◆ Results for residential customers
  - 12% reduction when faced with critical peak prices and no technology
  - 30% to 40% reduction for customers with air conditioning, technology, and a critical peak price.
- ◆ PG&E and SDG&E will install advanced meters soon, SCE will follow, starting 2008.

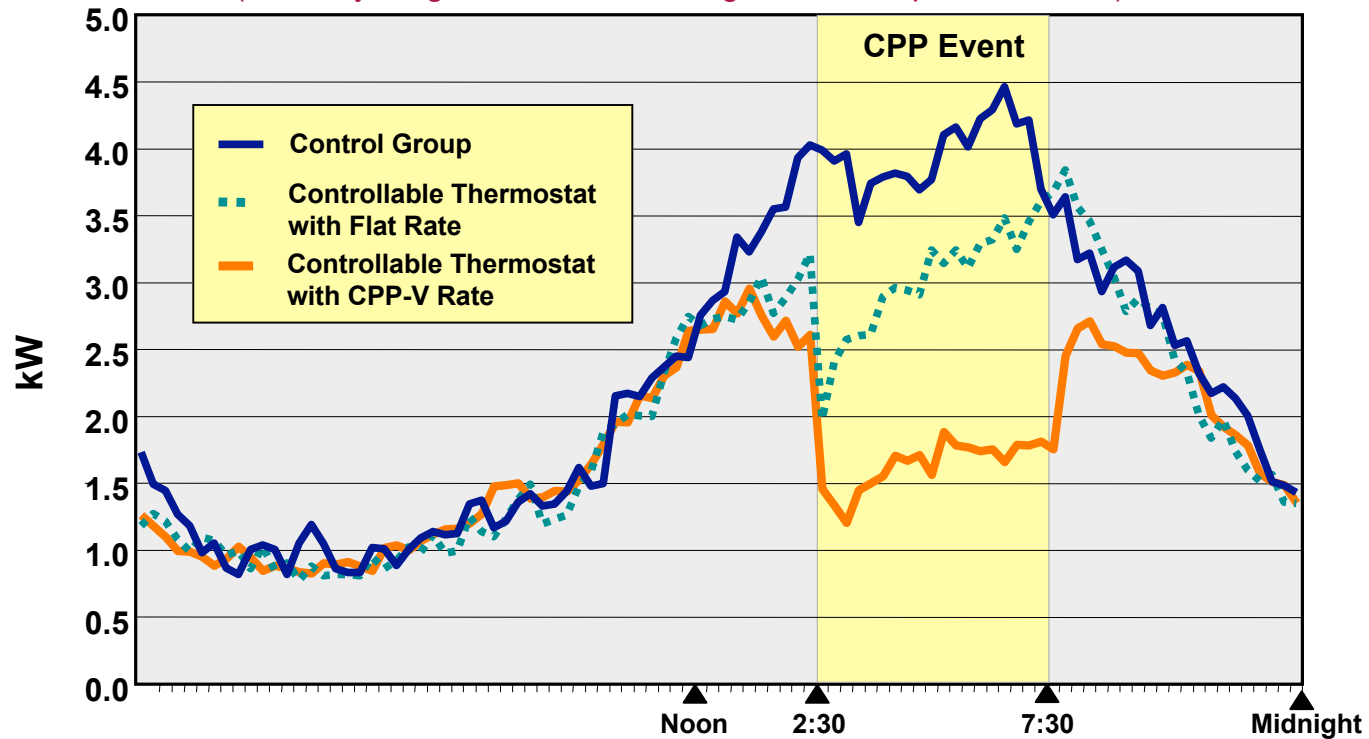
**Starting late 2008, ALL new bldgs. must have advanced meters and Programmable Communicating Thermostats (PCTs)**

## CPP rates – Load Impacts

### Residential Response on a typical hot day

#### Control vs. Flat rate vs. CPP-V Rate

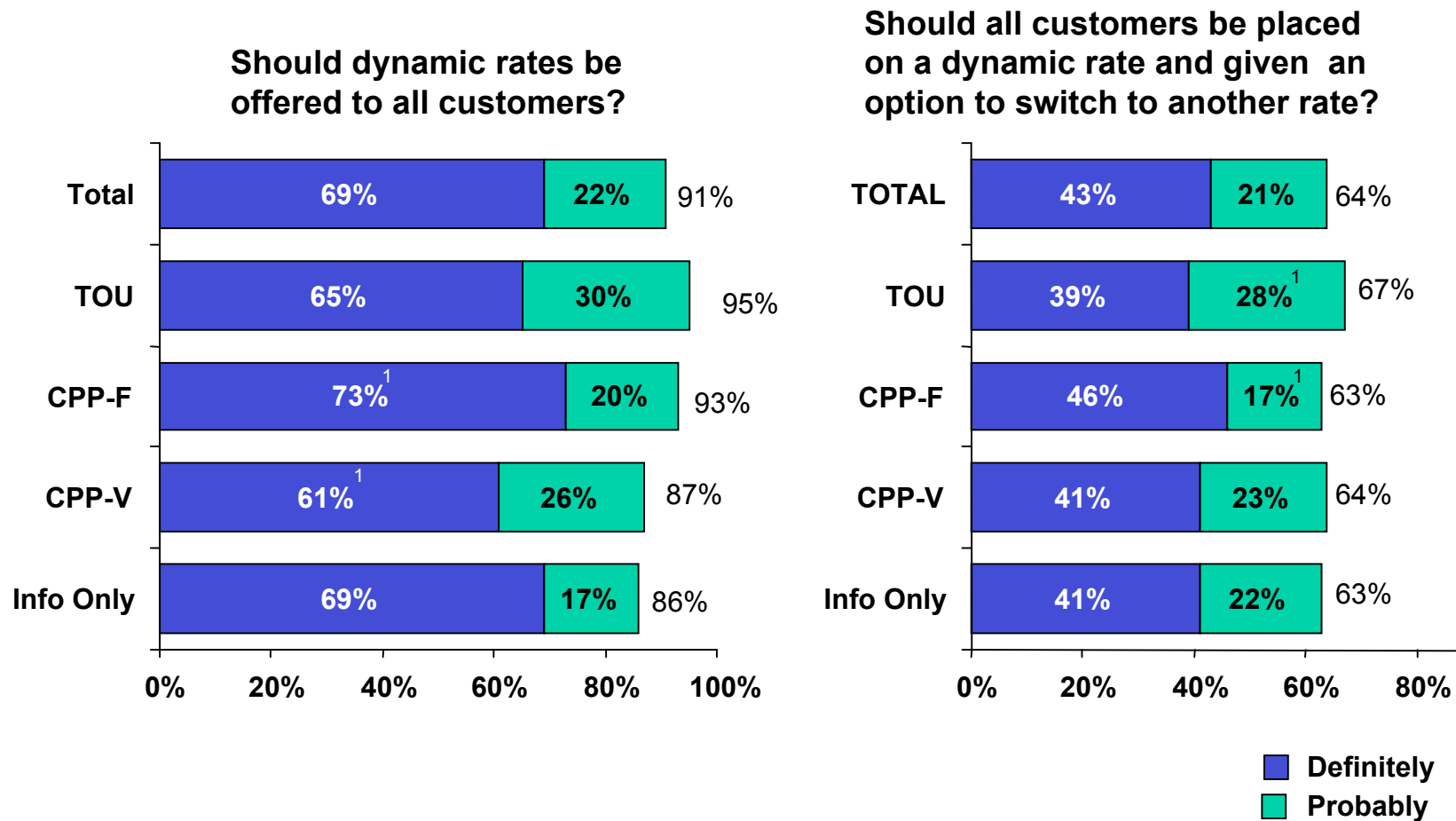
( Hot Day, August 15, 2003, Average Peak Temperature 88.5°)



Source: Response of Residential Customers to Critical Peak Pricing and Time-of-Use Rates during the Summer of 2003, September 13, 2004, CEC Report.

## Customer Acceptance of CPP rates

**Residential participants express a strong interest in having dynamic rates offered to all customers.**



Source: Statewide Pricing Pilot: End-of-Pilot Customer Assessment, December 2004, Momentum Market Intelligence.

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◆ This talk available on  
my web page

◆ Just Google

“Art Rosenfeld”

Source: Stabilization Wedges: Pacala and Socolow, Science Vol 305, page 968

